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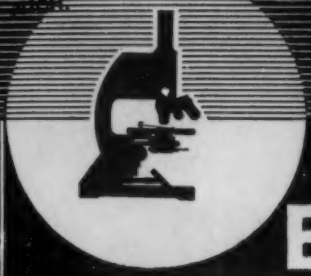

SCIENCE EDUCATION

THE SCIENCE MAGAZINE FOR ALL SCIENCE TEACHERS
FORMERLY GENERAL SCIENCE QUARTERLY

Does High School Science Teach Scientific Thinking?

Academic Requirements Necessary to Teach Science

Coördinating Electricity and Magnetism in Elementary Science

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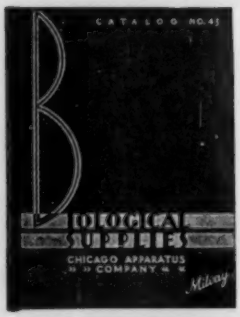

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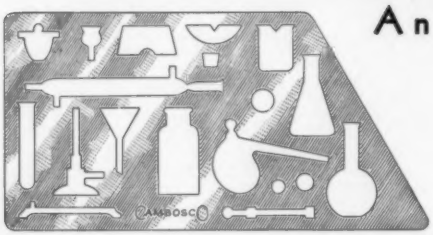

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Science Education

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Volume 17 APRIL, 1933 Number 2

Does Science Teach Scientific Thinking?

ELLIOT R. DOWNING
University of Chicago

Science is both organized knowledge and method, and the latter is more important than the former in the life of the average man, for he is bound to encounter many problems which will be successfully solved only as he is skillful in accurate scientific or reflective thinking, while needed knowledge can be obtained from books as occasion requires.

There is apparently little or no instructional material in current high-school science texts organized for the purpose of directly imparting skill in this important art. Possibly such an outcome is not considered an appropriate objective for high-school science. Or perhaps it is hoped that it will be achieved as a necessary by-product in the study of science subject matter, that the pupil who learns his science as organized knowledge will concomitantly acquire the method of the scientist. It would be interesting to know in how far this hope is justified by the facts in the case. The evidence offered herewith is not sufficient to be conclusive; it may be provocative of further investigations along this line.

The author has devised a test of some of the elements and safeguards of scientific thinking and, through the kind coöperation of several high schools and of some graduate students, has had it administered to some twenty-five hundred pupils from the eighth to twelfth grades, inclusive.

The returns do show a gradual and fairly uniform increase in the percentage of correct answers from grade to grade. The average score for 300 8th grade pupils is 35.3; 700 9th grade, 40.8; 300 10th grade, 47.9; 700 11th grade, 50.4; 500 12th grade, 54.2.

But now the question is, in how far is the science work responsible for the increase? If a comparison could be made of the scores of pair of pupils with the same I.Q., one of whom in each pair had had little or no science, the other much, the evidence, if abundant, would be to the point. Unfortunately, the I.Q. is not recorded for all pupils in the schools used in the study and there are not many pupils who have taken no science.

Here are the returns from the seniors in high school No. 2.

3	with 4	years of science,	Av. I.Q. 107	Average score	67.2
7	with 3½	years of science,	Av. I.Q. 106	Average score	69.7
26	with 3	years of science,	Av. I.Q. 99.3	Average score	64.3
13	with 2½	years of science,	Av. I.Q. 103.2	Average score	62.0
45	with 2	years of science,	Av. I.Q. 95.2	Average score	57.2
21	with 1½	years of science,	Av. I.Q. 97.7	Average score	58.5
2	with 1	year of science,	Av. I.Q. 106.5	Average score	68.0
1	with 0	years of science,	Av. I.Q. 104	Average score	59.5

The results from the juniors in the same high school are as follows:

2	with 2½	years of science,	Av. I.Q. 104.5	Average score	57.5
16	with 2	years of science,	Av. I.Q. 97.9	Average score	55.6
30	with 1½	years of science,	Av. I.Q. 101.7	Average score	55.6
109	with 1	year of science,	Av. I.Q. 99.1	Average score	49.3
23	with ½	year of science,	Av. I.Q. 97.4	Average score	52.6
39	with 0	years of science,	Av. I.Q. 103.8	Average score	55.4

Among these juniors it was possible to pick out fifteen pairs of pupils with the same or almost the same I.Q., one of each pair having had two years of science, the other, no science. Their scores follow:

Two Years of Science		No Science	
I.Q.	*Score*	*Score*	*I.Q.*
128	77.5	54	126
106	64	62	106
106	55.5	60	107
105	58	45.5	105
105	66	67.5	104
104	52.5	57	104
99	60.5	71	99
96	47.5	57.5	97
96	56.5	59.5	95
94	41	32	93
94	56	58.5	95
93	55	44.5	93
92	60	57	92
91	43	53	91
84	53	84	64

It will be noted that in nine cases out of the fifteen the pupils with no science make higher scores than those who have had two years of science.

The average scores on the test for the seniors in high school No. 3 are as follows:

31	with	¾	years	of	science	50.9
43	"	2½	"	"	"	53.5
33	"	2	"	"	"	50.4
37	"	1½	"	"	"	51.6
44	"	1	"	"	"	44.6
12	"	0-½	"	"	"	51.3

Again, a comparison of 13 pairs of seniors in this high school, every pair with the same C.I., one of each pair with no science, one with 3½ to 4 years of science, reveals an average score of 51.6 for the former and 50.5 for the latter.

The scores for the juniors in the same high school are

4	with	2	years	of	science	43
93	"	1½	"	"	"	48.1
74	"	1	"	"	"	43
20	"	½	"	"	"	46.5
9	"	0	"	"	"	51.9

If the scores be grouped in three classes, high, medium, and low, we find that the 48 juniors and seniors with no science have a larger proportion in the A (high) group than have juniors and seniors who have had one year of science in every problem, a larger proportion in A group on every problem but two than those with two years of science, and a larger proportion in A group on five out of fifteen problems than those with three to four years of science.

This superiority on the part of those pupils with 3-4 years of science is due to the fact which Davis has established, tentatively at least, namely, that for the most part only students with relatively high I.Q. take the chemistry and physics in high school, and is not due to the increased amount of science. This statement is based on a goodly body of evidence in the returns from the tests which will be presented in a later article.

The conclusion seems apparent that there is no evidence in the data given that high school pupils acquire skill in scientific thinking as a necessary by-product of the study of scientific subjects as at present taught.

Attitudes and Skills in Elementary Science

FLORENCE WELLER
Institute of School Experimentation
Teachers College, Columbia University

While appreciating fully the necessity of more scientific observation, what we chiefly need I believe, is not so much to increase the expertness of the expert in the hope that thereby we shall automatically increase the consensus of consent, but for all of us to acquire the scientific attitude of mind, to base our life on actual experience, of my own plus that of others, rather than our preconceived notions. Much of our present clamor for the expert is, I fear, a "defense reaction," a confession of our own weakness. Many of us are calling for experts because, acutely conscious of the mess we are in, we want someone to pull us out. What we really wish for is a "beneficent" despot but we are ashamed to call him that so we say scientific investigator, social engineer, etc. . . . The social process is a process of coöperating experience, but for this every one of us must first acquire the scientific attitude of mind. This will not make us professional experts: it will enable us to work with experts and to find our place in a society which needs the experience of all, to build up a society which shall embody the experience of all.[1]

A cursory review of elementary science courses of study will show that science teachers generally support this point of view, for in the list of objectives will be found everything from simple unassuming aims like, "Only a beginning can be made in the elementary school but attitudes may be created and fostered that will be far reaching in their influence"[2] to such presumptuous statements as the following:

To fit the child for better citizenship:

By developing attitudes of open-mindedness and sympathetic tolerance in considering problems of economic, political, social, religious, and industrial life.

By increasing the growth of honesty, truthfulness, unselfishness, loyalty, courage, perseverance, and righteousness, among individuals, groups, and peoples.[3]

or such a statement as this:

Spiritual attitude: To develop his reverence for life and his spiritual appreciation of nature's beauty, mystery, and greatness. To increase the child's sympathy with nature and to help him overcome his superstitious prejudices, needless fears, and desire to hurt or kill unnecessarily.[4]

These are some of the extravagant claims made by course of study workers which have hindered rather than promoted progress along the line of elementary science.

And even with reasonable aims, one must do more than include a statement of them in a preface of a Course of Study. Moreover, there are no trick devices by which the untrained teacher, or even the trained teacher, may develop the desired attitude. And yet attitudes are the things by which we live. Curtis says of attitudes that they are the "distinction between facts and what one knows about them."[5] Andress expresses the opinion

that they are "a set of mind which determines one's response to a particular situation."[6] Thurstone defines the word attitude as a "concept used to denote the sum total of a person's inclinations and feelings, prejudice or bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic."[7]

The *Thirty-first Yearbook of the National Society for the Study of Education* gives an excellent explanation of scientific attitudes and suggests how they are to be developed:

> Attitudes are also necessarily concomitant with the understanding of ideas and the understanding of methods. In their origins, attitudes are based upon understanding (or lack of it), and they are the reaction of a personality to learning experiences. Desirable attitudes, that is, attitudes that are consistent with truth, are the ones that are formed as a result of satisfactory experiences in learning.[8]

Even so, one cannot go into a classroom laden with such psychological definitions and pedagogical objectives and mould into human material attitudes towards problems economic, political, social, religious, and industrial. The problem is not a simple one but some beginning must be made. A plan has already been suggested by Craig in his statement of such definite concepts as:

> Man's conception of truth changes
> It is desirable to have confidence in the scientific method
> Nature's principles are invariable
> There is a cause to every effect
> Much knowledge remains to be revealed
> The formulation of hypotheses and testing them by experimental study are essential steps in the scientific method[9]

These statements are not so vague and intangible and do suggest subject matter by means of which the concepts may be developed.

The Problem

What are some of the attitudes and skills we can expect to develop in elementary science?

Part I

Procedure: In two units of study for sixth grades, one on "Our Universe," and the other on "The Adaptability of Plants and Animals to Their Environment," an attempt was made to direct both teachers' and children's attention to attitudes as well as factual knowledge. Two true-false tests were constructed for each unit. The first half of each test consisted of items like the following:

> Stars have five points
> A person dies because a star falls
> The moon shining on a person's face will cause him to go crazy

As more discoveries are made concerning the stars we may change our ideas about them

Your future can be told if it is known under what stars you were born

Playing with frogs makes warts on your hands

The earth is always changing

No two plants or animals are exactly alike

Man is one of the higher animals

Muskrats build their houses higher than usual if the winter is to be a severe one

These two tests were paralleled with tests containing factual items on the same subjects. These tests were given to 450 children in the sixth grade in the Baltimore schools as pre-tests and finals. *Results:* In Tables I and II are given some of the results of the tests. Tests IA and IIA are the attitudes items and IK and IIK the knowledge items.

TABLE I

MEANS ON PRELIMINARY AND FINAL TESTS I AND PER CENT GAINS

Class	Preliminary		Finals		Per Cent Gains	
	IA	IK	IA	IK	IA	IK
A	4.28	3.78	16.00	14.00	51.6	51.1
B	3.29	3.32	18.49	12.35	63.3	45.2
C	4.44	3.00	17.00	13.03	52.3	50.2
D	4.26	2.63	9.21	10.51	21.0	39.4
E	2.49	2.76	10.80	4.46	34.7	8.5
F	5.39	2.52	9.80	7.23	18.4	23.6
G	4.96	5.34	19.59	16.25	61.0	54.6
H	5.26	4.00	18.33	13.11	54.5	45.6
I	3.48	4.05	16.50	10.85	54.3	34.0
J	4.32	3.79	11.84	12.31	31.3	42.6
K	7.25	4.39	18.21	12.14	45.7	38.8
Average Per Cent Gains.....					44.4	39.4

TABLE II

MEANS ON PRELIMINARY AND FINAL TEST II AND PER CENT GAINS

Class	Preliminary		Finals		Per Cent Gains	
	IIA	IIK	IIA	IIK	IIA	IIK
A	4.00	2.14	21.21	18.14	71.7	80.0
B	2.62	2.09	5.65	6.56	12.6	20.9
C	2.32	2.89	15.43	12.97	54.6	50.4
D	.76	1.52	18.55	14.10	74.1	62.9
E	1.00	1.76	8.45	8.94	31.0	30.9
F	5.84	3.51	18.89	11.77	54.4	41.3
G	4.35	2.86	15.44	17.02	46.2	70.8
H	1.00	2.53	5.66	7.75	19.4	26.1
Average Per Cent Gains.....					45.5	47.9

The reliability on the first attitudes test was .74 corrected. I think this coefficient is significantly high since on further refining of the same test it came up to .83 and even in its first form it was a part of a test of several sections, the reliability of which was .84. The correlation of scores on this test with I.Q.'s was .24. Testing by item analysis for internal consistency 40 out of 48 items were considered good. A correlation between teachers' judgments of superstitious children made on a relative scale marked off in fifths and scores on the attitudes test was .60.

The second test was not treated statistically in the same manner but, since it was based on the same criteria and planned in a similar way, can be assumed to be as valid as the first, especially since the reliability on test I complete was .84 corrected, and on test II complete .82 corrected.

Implications: These results show that equal gains have been made in the learning of attitudes items and of knowledge items, that is, so far as paper and pencil methods go in testing these facts. Many questions immediately arise in one's mind. Are the attitudes really developed so that they are a part of the child or have the children merely learned which items to check true and which false for purposes of the examination? In other words is it functional learning that will affect the behavior of the learner? Is the learning of the attitudes items concomitant with the mastery of the factual items? Upon what does the development of these specific attitudes depend?

Part II

Procedure: A second experiment was tried in which three sets of tests were used: IA and IIA, true-false examinations of 45 questions each based on superstitions and erroneous conceptions connected with the topic; IT and IIT, a multiple choice examination of 21 items, constructed so that the first question of each set attempted to measure observation, the second a conclusion drawn, and the third a proof or possible verification of the conclusion drawn; IK and IIK a true-false examination of 17 items each testing factual knowledge only.

A few examples are given:

A

1. Finding a four leaf clover brings good luck.
2. A person dies because a star falls.
3. To go to sleep while looking at the moon causes nightmares.
4. Muskrats build houses higher than usual if the winter is to be a severe one.

T

1. You can find out whether the sun is in different parts of the sky at different times of of the day by
   a. reading about it.
   b. asking your teacher.

c. asking your father or mother.
d. looking to see for yourself.

2. If you notice that the sun is in a different part of the sky at different times of the day it is because
   a. either the sun or earth moves, or both move.
   b. somebody moves it.
   c. it is drawn across the sky by the sun god.
   d. it is so far away.
3. You could prove whether your answer in number 2 is right by
   a. talking it over with another boy or girl.
   b. asking a man who studies about the sun and stars.
   c. doing an experiment.
   d. deciding for yourself.

1. If it is a clear day on February 2 and the ground hog sees its shadow
   a. there will be bad weather for 40 days after that time.
   b. we may or may not have bad weather.
   c. it is a sure sign of rain.
   d. we will have good weather for 40 days after that time.
2. If it does rain for 40 days after the ground hog has seen its shadow
   a. it is a sure sign that it must always do it every year.
   b. it may just have happened that year.
   c. it is a good weather forecast.
   d. it will certainly happen again next year.
3. You can best prove your answer to number 2 by
   a. asking the keeper of the zoo.
   b. noting for several years whether or not we have had bad weather after the ground hog saw his shadow.
   c. asking your father or mother.
   d. looking it up in a science book.

K

1. Green leaves manufacture their own food.
2. A star is a sun.
3. The moon shines by a reflected light.
4. Muskrats hibernate in winter.

The reliability of test I complete is	.89	corrected
IA	.83	"
IT	.54	"
IK	.85	"

Test II, since it was planned in the same manner and used items of about the same difficulty, can be assumed to be equally reliable, especially since, in the previous experiment, using these items with slight differences showed test I with a reliability of .84 and test II with a reliability of .82.

Six sixth-grade classes in the Baltimore schools were taught these two units. In three of the classes the attitudes and techniques were stressed. Erroneous conceptions were deliberately brought up and discussed and superstitions argued about. One method of scientific thinking, that is observation of much data, drawing a conclusion from it, and attempting to verify this conclusion was practised, using simple problems of the children.

In the other three classes only factual items were discussed. If a question were asked involving other than factual information it was answered correctly but no attempt was made to continue the discussion.

From these six classes of 230 children the scores of a group of 60 who were equated on I.Q.'s, M.A.'s, C.A.'s and scores of Stanford Reading Tests were chosen for comparison. Thirty of these children were in the classes in which factual knowledge alone had been taught (this group will be known as the control group), and 30 in classes in which attitudes and techniques had been stressed along with the teaching of factual items (this group will be known as the experimental group). In all cases the children were enthusiastic about the work, since the material was new to them and different from the usual school subjects.

TABLE III

COMPARISON OF MEANS AND S.D.'S OF EQUATED GROUPS ON ATTITUDES, TECHNIQUES, AND KNOWLEDGE

	IA		IT		IK		IIA		IIT		IIK	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Experimental	59.1	10.1	56.2	3.5	64.7	3.7	58.4	12.3	78.1	2.8	40.0	2.9
Control	28.9	9.4	42.2	2.1	62.9	2.5	17.8	8.8	61.4	2.2	55.3	2.1
Differences	30.2	2.5	14.0	.74	1.8	.81	40.6	2.7	16.7	.65	15.3	.65
Differences	12.1*		18.9*		2.2*		15.0*		25.7*		23.5†	
S.D. of Diff.												

* In favor of experimental group.
† In favor of control group.

Results: Here the experimental group had a mean percentage of 59.1 and an S.D. of 10.1 on the first attitudes test while the control group had a mean percentage of 28.9 and an S.D. of 9.4. The means were compared throughout the report in terms of percentages because of the unequal numbers of items in each test. The differences in the attitude and technique tests are significant and in favor of the experimental group. In test IK the difference in favor of the experimental group is not significant, while in IIK the large difference in favor of the control group is significant. No explanation can be given for the first difference unless it is the fact that the material in IA was more suggestive of the factual material in IK than was the material in IIA suggestive of the material in IIK.

In order to eliminate this last difference, test scores in IA and IIA, IT and IIT, and IK and IIK were combined with the following results.

TABLE IV

COMPARISON OF MEANS AND S.D.'S OF EQUATED GROUPS ON ATTITUDES, TECHNIQUES, AND KNOWLEDGE

	A		T		K	
	M	S.D.	M	S.D.	M	S.D.
Experimental	58.8	19.6	67.1	5.6	51.5	5.1
Control	23.3	15.4	51.9	3.9	60.6	3.7
Differences	35.5	4.2	15.2	1.2	9.1	1.1
$\frac{\text{Differences}}{\text{S.D. of Diff.}}$	8.5*		12.7*		8.3†	

* In favor of experimental group.
† In favor of control group.

Here are some marked results showing that attitudes and skills may be more definitely developed when the teacher and pupils are conscious of an effort in that direction rather than expecting these results as concomitants to the mastery of knowledge. We may teach a child about the size, distance, and material of a star, but he may still think it has five points because he has always seen it drawn that way; or he may believe that fortunes can be told from stars.

Finally, a comparison of the entire population was made, inasmuch as equating groups on brightness quotients seemed to have little reasonable support, the correlation between the attitudes test and the I.Q.'s being .24. Subsequently, the following table of data from 6 classes (180 children) since only 180 complete records were attainable, was made.

TABLE V

COMPARISON OF MEANS AND S.D.'S OF NON-EQUATED GROUPS ON ATTITUDES, TECHNIQUES, AND KNOWLEDGE

	A		T		K	
	M	S.D.	M	S.D.	M	S.D.
Experimental	54.6	15.4	66.3	6.4	53.8	5.0
Control	23.8	17.8	39.0	5.6	47.9	4.9
Differences	30.8	2.5	27.0	.89	5.9	.74
$\frac{\text{Differences}}{\text{S.D. of Diff.}}$	12.3*		31.0*		8.0*	

* In favor of experimental group.

Here in all three cases there are significant differences in favor of the group that was taught with stress on the attitudes and techniques. One class in this group was decidedly superior to any other class taught, which partly accounts for the difference in knowledge items learned. The differences in attitudes and techniques are still significant which strengthens the point made in comparison of equated groups.

Conclusions

It seems reasonable to conclude that the teaching of elementary science with proper guidance provides an opportunity to grow in other ways than in the accumulating of factual material; that the material of elementary science provides the means of developing desirable attitudes and skills in problem solving, if attention is focused on this aim; and that some beginning has been made in determining the effects of instruction upon superstitious beliefs associated with the phenomena that are studied.

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Scientific Textbook Selection

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Scientific Procedure not Easily Employed

Science teachers are as fair minded, and as free from stultifying prejudices, as any other group of teachers: to claim more would be to fall into the error of unsubstantiated assertion. The extent to which transfer values of scientific training accrue is still questioned. We may, however, easily demonstrate that science teachers experience difficulty in applying the scientific method to their problems of teaching. Many teachers express a positive aversion to so much as making the attempt. No doubt this distrust is fostered and accentuated by the pronounced contrast between the established effectiveness of this method in the physical sciences and its new-born falterings in the psychological and social sciences.

Be the explanation whatever it may, any attempt to apply scientific, objective methods to the selection of a science textbook is commonly met by indifference, reticence, or even frank objection. As one veteran teacher expressed it: "Anyone of experience can take a group of textbooks home, sit down before his fire, and in an evening determine which is best by sketching through the books and reading a few passages from each." A few months later, this same veteran, after a convincing experience in applying scientific methods to the selection of a textbook, confessed to his fellow teachers in open meeting: "I never expected to change my opinion on this matter, but now I am just as strongly convinced that the scientific analysis and evaluation of textbooks is the only procedure to follow as I was certain before that it was impractical, if not impossible." He had just witnessed a group of teachers make an all-but-unanimous choice of a textbook in a field in which there had been severe contention over a long period of years.

A Scientific Procedure

In Los Angeles a scientific procedure for the analysis and evaluation of textbooks has been in the process of development over a period of years. Florence D. Fuller conducted the first experiments.[1] In the field of science, the method has been applied at various stages of its development to the selection of textbooks for chemistry,[2] general science,[3] physics,[4] botany, and advanced biology.[5]

Varying degrees of success have attended these and other evaluations, depending upon the skill of those who made them, their ability to obtain

significant data, and especially their ability to distinguish between objective analysis and evaluation. To be successful, the analysis must be made as far as possible in objective terms. After data are available as to the characteristics of the books from which a choice is to be made, and not before, they should be evaluated; that is, a judgment should be rendered as to their relative merits. Judgments may well be rendered separately on each of several features, such as vocabulary, provision for individual differences, or interest value. There must, however, be a final judgment as to the relative merits of the books as units.

Before a textbook for any secondary-school subject is recommended by the educational staff for adoption by the Los Angeles Board of Education, all books under consideration for that subject are examined critically and described in objective terms, so that valid comparisons can be made and the relative merits of the several books determined. This objective description contains information relative to the following features.

1. *Subject-matter:* The content of each book is outlined so as to indicate major divisions. Two or three representative divisions are outlined. Comparison is made with the course of study as already adopted.

2. *Language:* The following major phases of the language used in each book are analyzed.

a. Vocabulary:

1. Non-technical: The Lewerenz Vocabulary Grade-Placement Scale[6, 7, 8, 9] has been found especially useful as an instrument for the analysis of textbooks; and the Vogel-Washburne technique,[10] or similar means are used.

2. Technical: The kind of study made is determined in large measure by the subject-matter under consideration.

b. Sentence structure:

The proportion of simple, compound, complex, and complex-compound sentences is determined. The Vogel-Washburne technique is suggestive.

c. Style and interest value:

When possible, evidence is secured by having pupils read the books and make comparisons. Teacher estimates are also valuable.

3. *Learning exercises and other teaching aids:* These aids are classified and counted, a controlled random-sampling method being used.

4. *Individual differences:* The provisions for individual differences are classified and counted by a procedure similar to that used for learning exercises.

5. *Format:* Binding, physical appearance, size of type, character of illustrations, quality of paper, and other matters of format are recorded.

In addition to the preceding types of information, evidence is secured concerning the educational philosophy and educational psychology of the books.

1. *Educational philosophy:* The educational point of view exemplified by each book is analyzed, succinctly stated, and supporting evidence obtained. The following suggestive questions are applicable to almost any subject-matter field. Although each question presents two unlike and contrasting ideas, it does not necessarily follow that one must be true to the exclusion of the other or that one is to be sought unreservedly and the other shunned relentlessly; in fact, a proper balance between the two is to be desired in most instances.

a. Is the subject presented from an academic or from a practical standpoint? Is learning encouraged for the sake of learning or because of the serviceableness of the thing learned?
b. Is the book "schoolish" or does it present the world in realistic fashion?
c. Is the subject presented in an isolated fashion or in its proper relation to the wholeness of life?
d. Are the drudgery phases of the task merely to be done or are they so presented that they will be undertaken with a full understanding of the reasons therefor?
e. Is the book pointed toward a mastery of accepted and established knowledge or toward an interpretation of present-day conditions and an anticipation of future needs?
f. Is the subject presented *in toto* or only those phases of it which are not already generally known by pupils at this stage and which are not effectively acquired outside of school?
g. Does the book encourage the development of a "standard" child or does it encourage individual differences?
h. Does it encourage memoriter methods or creative child experiencing?
i. Does it emphasize the tradition-accepting or the creating phases of life?
j. Does it merely provide information or does it direct attention to techniques of study and investigation?
k. Does it answer all problems raised or does it focus attention upon many problems that are left unanswered?
l. Does it emphasize adult affairs or the important immediate and future needs of the pupils?
m. Is the book concerned primarily with common life practices or with the improvement of those practices?

2. *Educational psychology:* The psychology of learning implied by the organization and presentation of each book is analyzed, succinctly stated, and supporting evidence obtained. The following questions are applicable to almost any subject-matter field.

a. Is the subject developed in such a manner as to proceed from the known to the unknown?
b. Does it proceed from the simple to the complex?
c. Are difficulties presented one at a time?
d. Does the book stimulate pupil initiative?
e. Does the book provide for distributed and frequent practice on habits and skills to be developed?

f. Is provision made for utilizing skills and abilities after they are once developed?
g. Are the goals to be attained made evident?
h. Are they within the ability of the pupils to achieve?
i. Do they appeal to the pupils as worth while?
j. Is provision made so that pupils may determine the degree of success with which they attain their goals?
k. Is the content interesting to the pupils?
l. Is it sufficiently varied?
m. Is it sufficiently difficult to challenge the pupils without being beyond their abilities?

After the analyses have been completed, all of the data are summarized as simply as possible, in order that the teachers may not be confused in studying the results of the committee investigations.

A central, coördinating committee supplements the reports of the objective examinations of the books with a statement of interpretation, evaluation, and recommendation. This committee is one of the first to begin work. It sets up the criteria or ideals by which to judge the merits of the several books on the basis of the objective descriptions supplied by other committees.

A Committee Report on an Evaluation of Textbooks for Advanced Biology

In order that the procedure herein outlined and discussed may be made as understandable as possible, the following report of a committee on the evaluation of textbooks for advanced biology is included. This report was made under date of February 12, 1932. The committee which made the investigation was first organized in November, 1931. The report was addressed to the teachers of biology, but was also submitted to the high-school principals of the city and the Superintendent's office, since both had to pass upon and approve the recommendations. California has a system of free textbooks. For the junior and senior high schools, each community makes its own adoptions according to some more or less well-established procedure. A statement of the Los Angeles procedure can be found in the two reports.[11, 12] The original report has been modified only by the omission of authors, titles, and publishers of the texts considered and committee signatures. Books are identified by copyright date and number of pages.

The following report is a summary of a much more extended compilation of data.

At present there is no textbook for this course. Makeshift arrangements have been made, such as using botany and zoölogy texts and library reference books.

Since there are many high-school biology textbooks on the market and we offer a tenth-grade course, it was necessary for the committee to select for detailed consideration only those books suited to the upper-grade

course. This was done both from the point of view of selecting the book best suited to the upper-grade course and of avoiding a book that might later be needed for the tenth-grade course. Since advanced biology is an upper-grade course, it appeared possible that an elementary college textbook might prove suitable. In consequence, a number of college textbooks were canvassed. In the end, the committee found the following three books most promising and made a detailed analysis of them:

. . . . 1930, 414 pp.
. . . . 1928, 358 pp.
. . . . 1929, 567 pp.

After the evaluation was well under way, it was learned that a new edition of the 1928 book was to be published in the near future. It was agreed, therefore, that unless this book should prove exceedingly promising for the course it should not be adopted, owing to the fact that we could not see the new edition and would be adopting an old edition which would soon be out of print. The book was, however, evaluated as carefully as the others.

The three books contain essentially the same subject-matter, save that there is a variation in fullness of treatment. All were found to be authoritative.

The 1930 text is the most complete and possibly the most logically organized of the three books. Probably it is too complete for a high-school book.

The 1928 text is nearly as complete in the range of subject matter but does not treat topics so fully. The treatment is also logical.

The 1929 text does not treat so many purely biological topics, nor is the organization so systematic from an academic point of view. The organization is, however, better suited to the high-school level. Many more topics involving application to everyday life are presented.

The following facts were ascertained relative to the vocabularies of the books:

	1929 Text	1928 Text	1930 Text
Vocab. Diff. Gr. Pl.	9.2	9.6	11.7
Vocab. Div. Gr. Pl.	9.6	10.1	14.5
Per cent of Simple Sent.	54	38	50
Per cent of Compound Sent.	5	13	7
Per cent of Complex Sent.	40	40	35
Per cent of Compound-Complex Sent.	1	9	8
Average number of words per sentence	18.5	22.0	18.1

A careful study of these data leaves one with some doubts as to the suitability of the 1930 text for high-school use, owing to the difficulty of the vocabulary. Some doubt also obtains regarding the 1928 text, owing to the complexity of sentence structure and length of sentences. The 1929 book is apparently well-suited to the level at which it will be used.

Pupils were given an opportunity to read the books and use them in a supplementary fashion. A few assignments were also made. These pupils found the 1929 book interesting and understandable. The superior pupils found the 1930 text also interesting and understandable, but the average and slower pupils found it to be entirely too difficult. The 1928 text was not found to be satisfying to any of the pupils.

The 1930 book contains no learning exercises. The teaching aids consist principally of diagrams (most of which are very clear and well-labelled), a section devoted to short biographical sketches of a partial list of eminent biologists of the past, a well-selected bibliography, an extensive glossary, and a good index.

The 1928 book contains no learning exercises, depending wholly upon the laboratory manual which accompanies the text. The book is well-indexed and is profusely illustrated with both good diagrams and excellent photographs. In this respect the book is probably superior to the other two.

The 1929 text contains many problems which are essentially laboratory exercises. In addition there are questions and suggestions at the close of each chapter. Each chapter also begins with questions which direct the reading of the book. As for other teaching aids: there are references for supplementary reading at the close of each chapter, the appendix contains suggestions on the preparation of cultures of Protozoa, a table of fuel values of certain foods, a health-habit score sheet, weight-height-age tables for boys and girls, and an outline for a suggested course of study in advanced biology; there is also a very comprehensive index.

Except for a bibliography, the 1930 book offers no help in providing for individual differences. The 1928 book offers no assistance in providing for individual differences. The 1929 text is helpful, because many problems, questions, exercises, and references are provided.

In format all three books are acceptable. The 1928 book, however, has the best format from nearly every viewpoint. The 1930 book is not firmly enough bound. The 1929 book is well bound and has type of good size, but the illustrations tend to be too small and to break into the reading matter unduly.

The 1930 book is not organized from the point of view of the high-school pupil. The subject matter is organized with respect to itself, not tending to proceed from the known to the unknown, but from the simple to

the complex. The logical organization does present difficulties one at a time. The book does not appear to stimulate pupil initiative nor to be within the ability of the pupils with whom it would be used.

The 1928 book does not aim to proceed from the known to the unknown, but from the simple to the complex. Its logical organization presents difficulties one at a time. There is little reason to believe that the book itself will stimulate pupil initiative. Goals are not set up, and as organized the content does not appear to be particularly interesting to high-school pupils.

The 1929 book is organized with respect to the psychological development and attitudes of high-school pupils. Because of the questions at the beginning of the chapters, the subject matter should be attacked with a problem in mind. The subject is developed from the known to the unknown, and in large measure from the simple to the complex. Difficulties are well spaced. Through the questions at the beginning and close of chapters and the problems, pupil initiative is stimulated. Habits and abilities acquired at one time are given an opportunity for expression later. The goals are made fairly evident through the questions asked at the beginning and end of chapters. These goals appeal to pupils as worth while and are within their ability to achieve. The contents are interesting and sufficiently varied to care for most ranges of ability. The organization is more psychological as compared with the other books.

The 1930 book presents the subject from an academic point of view and treats biology as biology without much consideration for the wholeness of life, but with due consideration for the other sciences. It is pointed toward a mastery of accepted and established knowledge rather than an interpretation of present-day conditions and an anticipation of future needs. Whether memoriter methods of creative experiencing would be encouraged would depend wholly upon the instructor. The book does not direct attention to techniques of study and investigation, nor does it tend to leave many problems unanswered.

The 1928 book may be characterized in the same manner as the 1930 text with respect to its psychology of learning.

The 1929 book presents the subject from a practical rather than academic standpoint, being realistic rather than "schoolish." The subject is related to life, being directed toward an interpretation of present-day conditions and an anticipation of future needs. The many questions, problems, and exercises tend to break up memoriter methods and to encourage creative experiencing. These devices also tend to direct attention to techniques of study and investigation, although no direct references to such techniques are made. Many problems are left unanswered.

The committee recommends the 1929 book as giving greatest promise

of being a satisfactory text for advanced biology as taught in Los Angeles.

This report was signed by a committee of six teachers and the author as adviser. Under the adviser's direction, the committee made the study along with their regular teaching duties in a period of a few weeks. Only three meetings of the committee were necessary.

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Studying Rocks in the First Grade

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Rock studies for Grades I are now a part of the primary-grade-science program in the Glens Falls Elementary School. This unit was taught in the three first grades this fall and aroused, we think, unusual interest among the children.

The unit, though it had been prepared in advance, was developed as a natural outgrowth of the children's interests and grew out of their science work. The unit lasted five weeks. Two twenty-minute science periods were held weekly. During one of these periods the writer gave instructions; during the other, the classroom teacher instructed.

In two of the first grades, "Rock Study" followed a unit on the difference between live things and things not alive. Growth and reproduction had been stressed as characteristics of living things. Illustrated lists of live things and things not alive were made. In both classes a big discussion arose over stones. Some children said stones grew; others said they did not. It is interesting to note here that five second grades also discussed the difference between things that are alive and not alive, but only in one class was the statement made that stones grow. In one of these first grades, the question was raised: How can we find out whether or not stones grow? The children had been planting seeds and tending growing plants and so they suggested the stones be counted, planted, watered, and watched. In working with the planting of seeds, we had learned that first graders are so curious about germinating seeds (particularly large ones such as horse chestnuts, and acorns) that they pull them up daily. Consequently seeds were planted between blotting paper and the glass of an ordinary drinking glass or a jar filled with dirt. Stones were similarly planted. The children watched them for several weeks and finally decided that stones did not grow but then came the question: Where did stones come from? In the other first grade the question of stones growing appeared late in the fall and in order to take advantage of a situation before snow came, the writer undertook answering it.

From this point on, the work covered in both classes was about the same, although the sequence of activities was different. The first group, having an earlier start, took up two topics: (1) "The Earth Is Made of Rock" and (2) "Pebbles Are Rounded by Running Water." The second group discussed only the former topic. These two groups were of the lower

first grades. A similar unit was started in a third group consisting of pupils in upper first and lower second grades. The work began in an altogether different manner but proceeded in similar fashion once the unit was started. The work progressed at about the same pace since this class was a much slower class than the two lower first-grade classes. The children in this third group were bringing "depression plants" to school. These are made by placing a solution of six tablespoons of water, six tablespoons of bluing and six tablespoons of salt colored with three drops of mercurochrome in an open bowl or dish in which there are three large pieces of soft coal. The class wanted to know what made the "plant grow." This led into a unit on evaporation and crystal formation. Interest in crystals was so great that the writer brought the children from their classroom into the science work-room of the school to see a collection of quartz crystals that had been made by pupils of the upper grades. Since the bedrock of our region is a sandy limestone, clear quartz crystals or large sizes formed as the sand was slowly dissolved by water percolating through the bedrock, can be found in certain places. In the science work-room the children saw several other rock and mineral exhibits. They showed particular interest in some water-worn pebbles. They took some of these back to the classroom. This led to raising practically the same question considered in the lower first grade: Where do rocks and stones come from?

In answering the question where do stones come from, the children in both lower first grades were asked to look out of the windows and notice the school yard. They saw grass, stones, and dirt. When questioned about what was underneath the grass, they said dirt and stones. A picture was drawn on the board showing grass growing out of the soil. When asked what was underneath the dirt, the answer in both cases was, "Water, because people dig down for wells." The writer explained that streams did run underground but that there must be something underneath the streams. "What is underneath any brook?" was asked. "Stones and dirt," was the answer and it was explained that was also true for underground streams. Discussion arose about whether there were any places where we could see what was down in the earth underneath the dirt and stones. Both classes suggested digging down and then later going into mines was mentioned. (Our locality is not near a mining district.) The writer pointed out that sometimes there were places other than mines where people had dug down into the earth. The subject of road cuts was raised and pictures illustrating cuts were made. The children were asked to watch for them and report on what they saw underneath the soil. A visit to a road cut would have been desirable but this was impossible at the time.

The question became enlarged to: "What was the earth made of?"

The steps leading from where do rocks come from to what is the earth made of were somewhat different in the third group but work from there on was about the same.

It was decided to draw a picture of the earth. Discussion about how to draw a picture of the earth began. In all three classes, the response was immediately, "Round." When asked how did we know it was round, the children in all groups gave practically the same reasons. They were: people can travel all around the earth; maps of the earth (globes) are round; if the earth weren't round, you would fall off. The shape of the earth had never been taught to them in school, yet the children seemed to have a functional picture of the earth. A circle was drawn to represent the earth. Globes, since they had been mentioned, were brought into the classrooms. These were compared with boxes. The children discussed what would happen if people tried to go around an earth shaped "like a box." The idea of people falling off when they came to the edge of such an earth was very amusing to the children.

Discussion was then started on what the earth was made of. The teachers reported no difficulties in getting the children to understand that the blue portions of the globe represented water while the other colors represented land. It was brought out by the teachers in discussions that underneath the land was rock. The drawing of the grass growing out of soil was repeated. Underneath the soil were placed horizontal lines to represent layers of rock. About this time reports began to come in of places where the children saw big rocks underneath the ground. They reported not only road cuts as had been suggested, but well borings in one case, and, in several cases, the river gorge through rock which is a conspicuous local feature. Such reports indicate many of the children understood that rock was underneath the soil.

A circle representing the earth was again drawn on the blackboard. It was filled in solidly with chalk and the word "rock" was printed inside the circle. This, though by no means a complete picture of the nature of the earth, is, in the writer's opinion, a satisfying picture for pupils of the first grades. On a higher grade level, the picture will be enlarged with the molten core theory.

It was brought out that the rock underneath the soil in Glens Falls is limestone. The groups were shown samples of limestone and asked to try to find the same kind of rock. The children in one group, housed in a building that has a limestone foundation and steps of limestone slabs, observed these. The sidewalks and foundations of houses in the school neighborhoods were observed by the classes. Many of these in the community are limestone. Pictures of limestone quarries were shown the children so that they could get a glimpse of how the slabs of stone were obtained.

Along with bringing in limestone specimens, the children also brought in granite, slate and coal. Granite is another common local rock, it being the bedrock in neighboring towns. It was explained to the children that granite is the rock underneath the soil around Lake George. The slate used locally comes from Granville, a town about 60 miles from here, where it is extensively quarried. Since many of the children had visited the slate quarries, it was pointed out that slate was the rock underneath the soil in Granville. Coal was explained as a rock found in the earth in many places far away from Glens Falls. Pictures of coal mines were shown. The class was told how coal was taken from the mines, placed on trains and brought here, and then later put in coal trucks and brought to people's houses.

The classes, at this point, when asked where stones came from, immediately responded that they were pieces of the rocks inside the earth. When asked if there were rocks under the oceans, as well as under the land, the classes decided that since the earth was made of rock, rock was underneath oceans too. To emphasize that the solid part of the earth was made of rock, it was mentioned that rocks were underneath the ice in the North Pole, too. Blue lines were drawn on the outside of the blackboard drawing of the earth to represent the oceans. A heavy white line was drawn to represent the ice of the North Pole. The South Pole, since it was not mentioned by the children in any of the groups, was omitted. The rest of the circumference of the circle was drawn in brown to represent the land. An orange was cut in half to show that the drawing was a cross section. Pictures of fields, polar regions, and oceans were shown to the children, and it was emphasized that underneath these was rock.

Snowfalls at this time prevented further rock collecting. In the spring, if interest in this topic is revived, collections of limestone and granite will be made in order to familiarize the children with these two rocks.

Pieces of rock were broken with a geological hammer to see what the rock was like inside. The children all felt the hammer first, noticing that it was a very heavy hammer. They quickly understood that a heavy hammer was needed to crack rock. Otherwise the hammer, instead of the rock, would be cracked. The rocks broken were fresh, unweathered specimens. Attention was called to the sharp edges of the pieces. These were compared with water-worn stones from school rock collections. The question then was, "What made some stones smooth and round?" Each of the children felt the sharp edges of the broken pieces and the smoothness of the water-worn stones.

It was suggested by the teachers that if the sharp pieces of stone were sandpapered, they could be made smooth. This was tried by the children. It was pointed out, though, that people did not go around and sandpaper stones to make them smooth. In one group, a child suggested that the wind

could blow sand over them. This idea was approved, but it was pointed out that the smooth stones were rounded on all sides. The class then said they could be blown around. Heavy, polished stones were produced and the children agreed that the explanation was not quite satisfactory. The teacher did say, however, that many times rocks were worn down by wind-blown sand. When asked "Where else is there sand that might rub over rocks?" the children answered, "At the bottom of brooks." The children were asked if there was any sand in brook water. Had it been possible, some brook water would have been brought in and the sediments carried by it would have been noted. A trip to a brook or the Hudson River would also have been taken. Perhaps these things will be done in the spring. It was pointed out that as water flowed it carried with it a lot of sand, dirt, and stones that wore down rocks and stones in brooks and rivers. This was truly a thrilling discovery to all classes. They attempted making polished pebbles from small pieces of limestone and found that it took a lot of sandpapering to accomplish the task. The classes decided it must take a long time for pebbles to be made from sharp stones in brooks.

The three teachers of the classes who taught this unit felt that the children understood the material covered and were greatly interested in the topic. This unit, the writer believes, gave the following facts to the children: (1) The earth is round; (2) The solid part of the earth is made of rock; (3) There sometimes are different rocks in different places; (4) Two common local rocks are limestone and granite.

These facts lead to the following scientific conceptions listed by Craig[1] among the objectives of elementary science:

The surface of the earth has not always had its present appearance and is constantly changing.

There are forces which have determined the present appearance of the surface of the earth.

The shape of the earth is approximately a sphere.

There is a contrast between organic and inorganic.

The outcomes of this unit were not only informational in the writer's judgment. An introductory acquaintance with rocks and with geologic and physiographic features was given. It also seems that some understanding of the relation between cause and effect could be claimed.

The material in this unit needs more experimental teaching before even adequate subjective judgments can be made. It also needs to be checked up by oral questioning. It will be interesting to note how much carry over there will be to the spring when further rock studies can be made. However, at present, it seems safe to say on the basis of the three classes taught that rock studies can be made to provide vital experiences for children in the first grade.

SUMMARY OF EQUIPMENT USED

Pictures	*Specimens*	*Apparatus*
coal mines	water-worn pebbles and stones	sandpaper
quarries	local limestone	geological hammer
polar regions	local granite	globe
oceans	slate	
	coal	

References Used

No reading material suitable for this grade level was found. The teachers were referred to the following books:

Loomis—*Field Book of Rocks and Minerals.*
Hawksworth—*Strange Adventures of a Pebble.*
General Science Textbooks.

REFERENCE CITED

[1] CRAIG, G. S. *Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary School.* Contributions to Education No. 276. New York: Bureau of Publications, Teachers College, Columbia University, 1927. 73 p.

Academic Requirements Necessary to Teach Science*

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2. Academic Science Requirements Necessary to Teach Science in Seventy-one Cities in the United States

A questionnaire was sent to 100 cities of the United States asking for information relating to the teaching of science in those particular cities. These cities represented every state in the Union. Replies were received from seventy-one city superintendents of schools, assistant superintendents, individuals in charge of personnel, and supervisors of science. A résumé of the findings is given below:

A. Cities over 500,000 population (not listed alphabetically)†

1. Candidates must take examination in science subjects to be taught; usually have a major in these subjects.
2. Master's degree with 26 hours in subject taught, plus 14 hours in other sciences.
3. Major in science to teach high school science. General science teachers must have had courses in physics, chemistry, and biology.
4. Examination in subject to be taught plus demonstration teaching lesson. Usually candidates have 30 semester hours in one science and at least 20 hours in other sciences.
5. Must take competitive examination in science. Candidates usually have a master's degree and have a major in one science.
6. Candidates must take examination. Physical science teachers must be able to teach physics and chemistry and must have had 15 hours in one and 8 hours in the other. Biology teachers need to be prepared to teach only biology and they must have 14 hours in that subject.
7. Science teachers must take an examination and have satisfactory college training in science.
8. Must meet state requirements in science which includes a master's degree or equivalent and can teach only in major and minor fields.
9. Science teachers must have at least 25 hours in the subject they are teaching.
10. Must meet state requirements in science, which include a master's degree or equivalent. Must have at least 30 hours as a major in science. Can teach only in major and minor fields.
11. Candidates must take competitive examination and give a laboratory and demonstration lesson in teaching science. Biology, physics, and chemistry teachers must have 25 hours in subject taught plus 20 hours in each of the other two sciences. General science teachers must have 25 hours general science, 10 hours chemistry and 10 hours biology.
12. Biology, physics, and chemistry teachers must have 18 hours in the subject taught. General science teachers must have had courses in both biological and physical sciences.

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* Concluded from the February issue.

† Cities in list: Baltimore, Boston, Buffalo, Chicago, Detroit, Los Angeles, Milwaukee, New York, Philadelphia, Pittsburgh, San Francisco, and St. Louis.

B. Cities from 250,000 to 500,000 population (not listed alphabetically).*

1. Biology, physics, and chemistry teachers must have had 30 hours in subject taught. If teaching two sciences, must have 20 hours in one science and 10 hours in the other. General science teachers must have 30 hours, as follows: 10 hours general science, 5 hours each in physics, chemistry, physiography, and physiology.
3. Science teachers must have 24 hours in major and 18 hours in minor—may teach in either field.
4. No specific requirements, but usually have a major in science.
5. Must meet North Central Association requirements, which are 15 hours in science of which at least 5 hours are in subject taught.
6. Must have a major in science taught.
7. No specific requirements except meeting state requirements of 6 hours in subject taught.
8. Must have major in science taught and minor in second science taught. General science teachers must have a major in physical science and at least a minor in biological science. Master's degree usually required.
9. Must have 18 hours in subject taught. General science teachers must have 18 hours in science, with representative distribution.
10. Science teachers must have at least 12 hours in subject taught.
11. No specific requirements.
12. Must have major in subject taught.
13. Must have at least a minor in science taught.
14. Must have at least 24 hours in subject taught, but many have 40 hours. Latter being made requirement.
15. Biology, chemistry, or physics teachers must have 30 hours in subject taught. If teaching two subjects must have 24 hours in one science and 6 hours in another science. General science teachers must have 6 hours each of chemistry, physics, biology, and physiology.
16. Must take competitive examination and may teach only in major and minor fields.
17. Must take competitive examination and have had a science major or minor in college.
18. Must have 12 hours in major subject taught and 6 hours in any minor subject taught.

C. Cities from 100,000—250,000 (not listed alphabetically.)†

1. Physics, chemistry, or biology teachers must have a major of 20 hours plus 12 hours in some other science. Requirements need to be raised to 30 and 18 hours, respectively.
2. Major in science taught. A general science teacher must have major in one science and work in other sciences.
3. Must have 20 hours in one science and 10 hours in another science.
4. Must have 24 hours in major and 16 hours in minor.
5. Must have had course in special methods and 24 hours in science taught.
6. Must have major in science taught. General science teachers must have major in biology or general science and minor in physics or chemistry, preferably physics.

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* Cities in list: Atlanta, Birmingham, Cincinnati, Columbus, Houston, Indianapolis, Jersey City, Kansas City, Louisville, Memphis, Minneapolis, Newark, New Orleans, Portland, Rochester, St. Paul, Seattle, and Toledo.

† Cities 100,000 to 250,000 population: Chattanooga, Duluth, Evansville, Ft. Wayne, Hartford, Long Beach, Oklahoma City, Omaha, Salt Lake City, San Diego, South Bend, Syracuse, Tacoma, and Tampa.

7. Major in subject taught and minor in other subject taught.
8. Must meet state requirements of major of 24 hours in one subject.
9. No specific hour requirements, but must have a major.
10. No requirements, but must be specifically trained.
11. Biology, physics, and chemistry teachers must have 12 hours in subject taught. If teaching two sciences, must have 9 hours in each. General science teachers must have 5 hours each of physics, chemistry, and biology.
12. Must have major in subject taught.
13. Must meet state requirements of 24 hours in subject taught.
14. Biology, physics, and chemistry teachers must have 12 to 24 hours in subject taught. If teaching an additional subject, must have 10 hours in that subject.

D. Cities with less than 100,000 population (not listed alphabetically).*

1. No set standards.
2. Must have 15 hours in subject taught. General science teachers must have 10 hours physical science and 5 hours biological science.
3. Science teachers must have 36 hours in major.
4. No set requirements, but may teach only in major and minor fields.
5. Must have a major in science.
6. Must have 12 hours in subject taught.
7. Major in subject taught and minor if second subject is taught. General science teachers need to have courses equally divided.
8. Must have 16 hours in major and 10 hours in minor.
9. No rule. Usually require a major.
10. Must have 19 hours in subject taught.
11. Must have 25-30 hours in teaching one science. If teaching 2 sciences must have 20 hours in the one science and 15-20 hours in the other science. General science teachers must have 30 hours science.
12. Must meet North Central Association requirements.
13. Must have major or minor in subject taught. General science teachers must have had well-distributed science courses.
14. Biology, physics, or chemistry teachers must have 15 hours in subject taught. If teaching 2 sciences must have 10 hours in one science and 5 hours in each of 3 other sciences. General science teachers must have 10 hours each of biology, physics, and chemistry.
15. Must have major in one science and good grounding in others. Accept only science majors.
16. Physics, chemistry, or biology teachers must have had 25 hours in subject taught, 10 hours in second subject taught. General science teachers must have 25 hours in science, well distributed.
17. Must meet North Central Association requirements, but usually have at least 20 hours in one subject. General science teachers usually have 30 hours.
18. Biology, physics, and chemistry teachers must have 10 hours in subject taught. General science teachers must have 20 hours well distributed.
19. Chemistry and physics teachers must have had 25 hours in subject taught and if teaching the other as a minor must have 15 hours in that subject. General science teachers must have 15 hours each of chemistry, physics, and biology.
20. No specific requirements except experience in that field.

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* Cities having less than 100,000 population: Appleton, Bellingham, Boise, Boulder, Burlington (Iowa), Burlington (Vt.), Charleston (S.C.), Cheyenne, Danville (Ill.), Decatur, Dubuque, Fargo, Fresno, Hannibal, Hibbing, Kokomo, Mobile, Montgomery, Oak Park, Pasadena, Passaic, Pawtucket, Quincy, Racine, St. Joseph, Superior, and Vicksburg.

21. No requirements, but teachers teaching one subject usually have a minimum of 30 hours in that subject.
22. Biology, physics, or chemistry teachers must have 20 hours in subject taught. If teaching an additional science subject must have 8 hours in that subject. General science teachers must have 8 hours each of biology, physics, and chemistry.
23. Biology, physics, or chemistry teachers must have 20 hours in subject taught and 8-10 hours in additional science taught. General science teachers must have 16 hours physics, 13 hours chemistry, 10 hours biology, 3 hours geology and 3 hours geography.
24. Must have a master's degree and 30 hours in major.
25. Must meet North Central Association requirements.
26. Must have a major in science taught—at least 24 hours—minor if other science is taught.
27. Major in science taught. Minor if additional science is taught.

The following table gives a summary of the science requirements by groups for the seventy-one cities.

	Group A	Group B	Group C	Group D
Require examination	6(50%)	2(11%)	0	0
Require major in science	12(100%)	10(55%)	9(63%)	14(55%)

In addition to the cities requiring a major in science, we find that in Group B, one city has no specific requirements, one requires that the applicant meet North Central Association requirements, one a minor in science, one requires at least 6 hours, three cities require at least 12 hours, and one city requires 18 hours. In Group C, one city has no specific requirements, two require 12 hours, and two require 20 hours. In Group D, three cities have no specific requirements, two meet North Central Association requirements, one city requires 10 hours, one requires 12 hours, two require 15 hours, one requires 16 hours, one requires 19 hours, and two require 20 hours.

In response to the question as to whether senior-high school teachers should teach one subject or more than one subject, 44 favored the teaching of one subject and 7 preferred teaching two subjects.

In replying to the question as to whether an examination was required, 8 said "yes" and 54 "no." However, the remaining 9 cities probably do not—at least no mention was made in the requirements listed.

In reply to the question as to whether or not it was believed that science teachers were sufficiently prepared, 23 said "yes" and 24 said "no."

A few sample replies to the question as to how science teaching could be best improved are here given:

ROCHESTER: "By clarifying objectives and providing opportunity for teacher to devote efforts in that direction as well as the traditional objective—memory of facts. Need adequate science program of 12 years in elementary and secondary schools. Need to emphasize in college courses, science training to teach science rather than science training for industry and research."

APPLETON: "Better coöperation between elementary, junior-high schools, and senior-high schools in content of science courses; for senior-high schools better reference books would help."

OAK PARK: "Better preparation in subject matter; broader background of science; less mechanical work in laboratory. Laboratory periods not over 60 minutes in length."

LOUISVILLE: "The idea that they are teaching children and not a subject. Too many want to give college courses in science. There is a great deal of science that all should have, regardless of the ability to study the subject as a science."

CHEYENNE: "Workbooks are not yet satisfactory; presentation of guide sheets to teach students how to get the most important parts; greater application to use outside school; more science training for teacher."

TOLEDO: "They are inclined to think too much about their specific subject and not enough about boys and girls."

PITTSBURGH: "A better technique of teaching and a philosophy of education and life."

EVANSVILLE: "Science teachers should realize they are to teach children. In my opinion our present teachers need most a working knowledge of mental hygiene in order to secure satisfactory child adjustments."

SEATTLE: "Practical knowledge of applications; liberally trained in the sciences and the humanities."

SALT LAKE: "They need a broad general training in all the sciences to begin with; they should keep up to the latest in their special line through science magazines; they should go away and take a course in the special subject from time to time."

BELLINGHAM: "Most of them need more training in the 'Art of Teaching' and the psychology of the adolescent youth, together with a general knowledge of the needs of society."

ATLANTA: "Science teachers should show a greater interest in their environment. Biology teachers should be thoroughly familiar with the plant and animal life of their particular community. They should also be able and willing to bring into the classroom real, live problems from the community. I also think teachers should continue to take professional educational courses and special courses in their particular field. My own feeling is that no live teacher can ever 'have sufficient training in pure science.' A live teacher will continue to study and grow professionally."

SAN DIEGO: "What is needed now more than anything else is (1) training in social sciences for science teachers to give perspective and (2) training in education methods, in order to break away from the infinite amount of lost motion in the laboratories. More appreciation of the contribution of science would come from more use of supplementary reading, and a reduced amount of 'fiddling' or puttering around in high-school laboratories."

MINNEAPOLIS: "A broader outlook in the field of applied science; a solidifying of pure science background; a better understanding of the interests and needs of secondary pupils in the field of science."

SUPERIOR: "Improve the cultural background of perspective teachers by taking other than science courses. Teachers of science who have the real scientific attitude tend to shut themselves up in a narrow scientific world and as a result teach *science* and not *boys and girls*. They are apt to become ultra-specialists. There is a happy medium. Ultra-specialism may go in college but not in high school."

CHARLESTON, S.C.: "Thorough courses in science; courses in high school methods; understanding adolescent psychology; training in making simple apparatus."

JERSEY CITY: "More and better training in methods of teaching their subject. More field work. Too many have been limited to classroom and laboratory experiences. A better understanding of high school youth and a desire to know the individual pupil's background, present environment, and future needs and desires."

NEW YORK: "A better knowledge of applied science is the greatest need. A biology teacher knows all about plant cells, but doesn't know how paper is made. A chemistry teacher knows all about sodium and chlorides, but cannot tell where table salt comes from. A physics teacher can give the theory of electrons and ether waves, but cannot hook up a radio set. To teach the pupils of adolescent age the teacher must know more than 'pure' science. He must know what the principles or processes are good for."

BOSTON: "Science teachers need definite and detailed courses of study accompanied by a careful description of suitable coördinated demonstration and individual laboratory experiments; a closer and more intimate contact with one another in regular intervals to exchange ideas on different topics or on new or original methods of presentation."

Replies to this question as to how science teaching could be best improved indicated that persons answering the questionnaire believe we can best improve science teaching by (1) a better understanding of boys and girls—the application of psychology of learning to the subject matter that is being taught, (2) more adequate preparation in the field of pure and applied science. Whether significant or not, no mention was made of the aims of science teaching and none whatsoever of developing scientific attitudes in the teachers themselves or in the boys and girls they are teaching.

Coördinating Electricity and Magnetism in Elementary Science

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There is nothing new in the inclusion of the subjects electricity and magnetism in a course in science for the elementary school. On the contrary, these are subjects almost never omitted, even "nature study" courses feeling obliged to sandwich in a few object-lessons as a concession to the perennial interest of children in electricity and magnetism. This popularity has produced a diversity of teaching materials and methods, many of them accidental in structure and trivial in content. The most common error in this respect is that of giving the subjects isolated consideration and failing to show the fundamental interrelationships which are essential to proper understanding and which are increasingly comprehended as research in electromagnetic theory progresses today. Frequently, we find all the work on magnetism given in one year and that on electricity in another year. Of course, the method of dividing the work in each subject and considering the subjects alternately for several years is better, but even with that method it is difficult to develop the essential correlation. Are we merely to assume that the child will, at the end of his elementary school career, be able to take all these separate parts he is supposed to have learned and integrate them into a correct whole?

A method of teaching development for electricity and magnetism that seems to be a satisfactory solution to these and similar problems is the basis for the sixth-grade unit outlined and described here. In the third and fourth grades in the Austin schools some relatively simple material is included on magnetism and electricity, similar to the units given in Craig's *Pathways in Science* for these grades. This material helps to produce an introductory practical familarity with the subjects that greatly facilitates the beginning of the following unit for the sixth grade. This unit is given a period of eight weeks in the course of study. The page references in the outline are for student's use.

ELECTRICITY AND MAGNETISM

A Unit for the Sixth Grade

I. What men knew about electricity and magnetism 2000 years ago.
   A. Electricity. *Craig VI: 287-289; Parker 9-11.*

1. They knew only that amber (*electron*—origin of *electricity*) picks up light particles when rubbed.
2. They did not know that lightning is electricity.

B. Magnetism. *Craig V: 113; Parker 96-97.*
They knew that certain peculiar, heavy rocks containing iron (lodestones), found in Magnesia, will pick up bits of iron.

II. What men began to find out a few hundred years ago.

A. Electricity. *Parker 6-9, 13-15, 15-20; Smith 212-213.*
1. They found that other substances, when rubbed, act somewhat like amber.
2. They found that two kinds of electricity can be made by rubbing, and that
   a. Like kinds repel
   b. Unlike kinds attract.
3. Franklin found that lightning is electricity. *Nida V: 41-49.*

B. Magnetism. *Craig V: 115-119, 122-128; Parker 90-92, 98-99.*
1. They found that they could make magnets of pieces of steel by stroking them with pieces of lodestone.
2. They discovered the compass. (The earth is a magnet.)
3. They found that the two ends of a magnet are different, one of them, as in the compass, always trying to point north, and that
   a. Like "ends" repel
   b. Unlike "ends" attract.
4. Some men thought that there might be a connection between electricity and magnetism.

III. Then men discovered new ways to make electricity. *Craig VI: 292-300.*

A. Electricity made by friction cannot be controlled—it tries to jump away. *Craig VI: 292.*

B. They found out how to make electricity so that it would flow in a steady stream—"electric currents" from batteries. *Parker 36-40, 22-24; Smith 215-217.*
1. Galvani and his frog legs.
2. Volta and the voltaic pile.
3. Wet cells.
4. Dry cells.

C. They found that some things will conduct an electric current and that others are insulators. *Parker 46-49.*

D. They found that a current will flow only if there is a "complete circuit." (The switch and the electric questioner.)
[Electronic concept introduced and used by teacher to explain B, C, and D. *Craig VI: 293-294; Parker 82-87.*]

IV. How men discovered that these electric currents are related to magnetism.

A. They found that every electric current makes a magnetic "field" when it flows, and that more current makes more magnetism. *Craig VI: 293-294; Parker 92-93, 100-101, 113-115, 123-133.*
1. A compass needle turns when an electric current passes near it—this makes a way for measuring electric currents.
2. A stronger magnet can be made by winding a long wire into a coil because all the magnetism is then brought together into a small space.
3. A piece of iron put into the coil makes a still stronger magnet, but
   a. If the iron is soft, it is a magnet only as long as the current is flowing
   b. If the iron is hard (steel), the magnet will not be as strong, but it will remain a magnet after the current has stopped flowing, and after it has been taken out of the coil.

B. Then they found that they could not only make magnets with electricity, but also could make electricity with magnets. *Parker 40-42.*
If a wire is moved near a magnet a current will flow in the wire if the current is complete.

V. How these relationships between electricity and magnetism are used practically.
A. The doorbell and telegraph. *Smith 220-221; Parker 134-137, 215-241; Nida V: 160-169.*
B. Motors. *Parker 171-174.*
1. Motors are made up of electromagnets so arranged that the electric current makes magnets and magnets attract each other, causing the motor to turn.
2. In a motor, electricity is "put in" and mechanical power is taken out.
C. Generators. *Parker 27-36.*
1. An electric current can be made by moving wires near a magnet—this magnet can be a permanent magnet, but an electromagnet is used because it is stronger and because more magnetism helps to produce more current. A generator is made just like a motor; in fact, a motor may be used as a generator.
2. In a generator mechanical power is "put in" to turn it and electricity is taken out.
3. Nearly all the electricity used today, the electricity that comes from the power plant, is made by using generators to change mechanical power of steam engines and waterfalls to electricity. This electricity is usually of a special kind called "alternating current" because it flows first in one direction and then the other, very quickly—sixty times every second!
D. The telephone. *Craig VI: 326-333; Parker 258-264, 271-281; Nida V:170-179.*
1. Bell's telephone.
2. The modern telephone.

VI. Other ways in which electricity is used.
A. Heating effect. *Parker 139-142, 146-147, 160-164.*
1. When an electric current flows through a substance that "resists" its flow, electricity is used up in overcoming this "resistance" and is changed to heat.
2. This heating effect is used in electric irons, toasters, stoves, heaters, etc. In electric light globe a small wire is heated so hot that it becomes white-hot and gives off light. An electric fuse is made so that when too much electric current flows through it, a short piece of lead wire becomes hot and melts, breaking the circuit.
B. Chemical effects. *Parker 183-189.*
In electroplating, the electric current carries tiny particles, too small to see, of a piece of metal in one part of a solution over to an object in another part of the same solution, coating the object with a thin layer of the metal from which the particles came. The object being electroplated must be something that will conduct electricity.

The most significant structural basis of the unit is immediately apparent —the parallel development of electricity and of magnetism. In this paralleling, every effort has been made to avoid confusion as a result of apparently considering two subjects at the same time by thoroughly coördinating the two types of material at every step. Even in Part I, the child senses a relationship between rubbed amber and the lodestone greater than mere historical contiguity. An adaption of the conventional historical development was adopted for the first portion of the unit to accomplish several purposes. For

one thing, the order of discovery in this branch of physical science coincides roughly with the logical order. Also the subtle inclusion of the narrative element aids teaching and unifies otherwise difficultly correlated material. Finally, the growth of scientific knowledge is illustrated and the certainty of further development emphasized.

Another structural characteristic that will be found upon closer examination is the attempt at perfectly sequential development. Each topic is based firmly upon previous material, being introduced only at a point at which the child can thoroughly comprehend it. In a number of cases the advantages of parallel development become obvious, particularly in the case of electromagnetism. This principle of rigid adherence to sequential development, while simple enough, was considered of great importance in the preparation of this unit; and teaching experience corroborates that evaluation.

The unit is to the highest attainable degree demonstrational in technique of presentation—the teacher does not, for example, merely relate what men knew about electricity and magnetism two thousand years age; with pieces of amber and lodestone she actually shows the class the extent of that knowledge, permitting them to repeat those early experiments themselves. Figure 2 is an example of one type of the demonstrational work (beginning the study of the motor). There are two major advantages in the extensive use of experimentation, especially of student experimentation, in a unit of this type: a correct attitude toward scientific knowledge is built up by introducing principles, like the reactions of magnetic poles, as verified experimental facts rather than as "laws"; and that practical familiarity which is essential to thorough comprehension, most of all, in such complex things as motors, is by such means produced. This extensive use of experimentation aids in an equally thorough application of one of the oldest and most fundamental of teaching techniques—that of problem-solving. Using the term in its most general sense, "problem-solving" is, of course, an integral part of all experimenting; and, in addition, the child finding some of his questions answered, largely as a result of his own investigation, is encouraged to ask more. Therefore there is little need for the formal proposal of problems, and the teacher's task becomes, happily, more that of a guide directing the interests of the class.

The subject materials used in teaching this unit are indicated only in a general manner. The classical demonstrations are included wherever they fit in and are supplemented by demonstrations suggested by special equipment, the teacher, and the pupils. The expansion of this outline for teaching purposes will, in most particulars, be obvious; however, explanations of several points will make the purpose and method of the unit clearer.

In the materials on electricity, particularly concerning electricity produced by friction, care has been taken to avoid making any distinctions among "static," "galvanic," and "dynamic electricities," as has often misleadingly been done. In order further to avoid confusion, only enough ma-

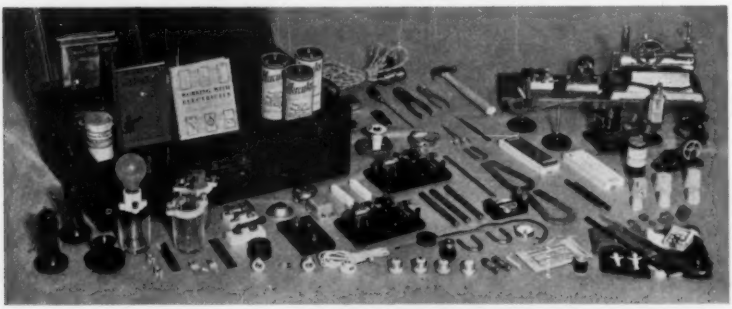

FIGURE 1.—Complete set of equipment supplied in a steel carrying case at the beginning of the unit.

terial to give a general familiarity with the phenomena associated with friction-produced electricity has been included.

As will be noticed in Figure 1, the equipment supplied includes two telegraph sets, and a telephone transmitter and two receivers. A telegraph

FIGURE 2.—Showing the relation of the electromagnet to the motor.

line running from one room to another arouses more interest than almost any other activity and forms an essential step toward the understanding of the motor. As a slightly more complex example of electromagnetic action, a set-up of the original Bell telephone, consisting only of two "receivers" and connecting wires, is made; this arrangement is then compared with the modern telephone composed of transmitter, battery, and receiver.

The conversion of energy is demonstrated by special apparatus shown in operation in Figure 3. Not only does this illustrate, in a general way, the

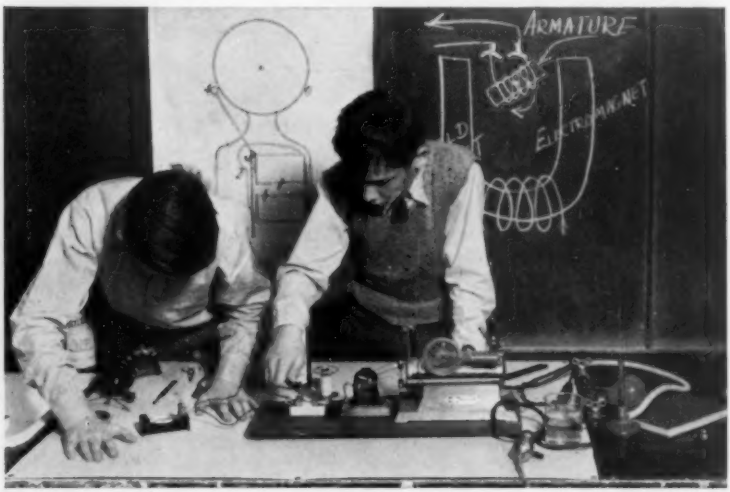

FIGURE 3.—Children demonstrating to the class the conversion of energy.

power station, but by making the conversion cyclical (electricity to heat to motion to electricity) the loss of power in these conversions is shown.

All through the unit, measurements of electric currents, that is, objective evidences of the flow of electricity, are necessary. In the work before Part IV, the selection of a current indicator was very difficult. A simple flashlight globe was finally chosen because the child through long acquaintance has come to accept without question the lighting of an electric lamp as evidence of the flow of electricity. In Part IV the principle of the galvanometer is introduced, and the simple tangent galvanometer may be used thereafter. An ordinary pocket volt-ammeter is included merely in order that the child may recognize the purpose of similar instruments when he sees them elsewhere: such electrical units of measurement as volts, amperes, and ohms are, of course, not introduced at this grade level. An

attempt is made to introduce rudimentary quantitative concepts, however, such as "more current makes more magnetism."

As will have been observed, rather strong emphasis is placed on apparatus. It is, perhaps, too simple to say that demonstrations should really demonstrate, but the statement carries more meaning when it is added that a vivid demonstration can best be obtained with apparatus that works properly. Not only is makeshift apparatus a waste of the teacher's time, but it also is a waste of pupils' time in that it does not show clearly the required principles. These remarks are not intended to imply that carefully-built homemade demonstration equipment cannot be successfully used or that construction of pieces by children is to be discouraged. On the contrary, construction by the children is particularly encouraged. It is, however, our observation that, considered in relation to results secured and satisfaction in use, commercially-built apparatus is cheapest and makes least demands on the already busy teacher. Further carrying out this purpose of economizing teacher-effort, a steel unit case containing every item that will be needed in the presentation of the unit, excepting the permanent equipment of the science room, is furnished to each teacher at the beginning of the unit. This case and its contents are shown in Figure 1.

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English Science Teachers

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In an endeavor to obtain information on what sciences are taught in England, the annual report of the Science Masters' Association for 1930 has been used as a source for data. On pages 37-70 of the report a list by schools of the members of the Association is given, together, in many cases, with what sciences they teach, this being obtained from the membership application forms. How accurate this data is it is difficult to estimate and although the results of the examination are given in a quantitative form, they are not in any sense to be regarded as anything more than qualitative.

In passing, it is interesting to note that 170 members included in the schools of England, Wales, and Scotland (northern Ireland and schools abroad have been excluded from this investigation for obvious reasons) give no indication of the sciences taught by them, at any rate so far as the annual report publishes the information. It would be most useful if in future reports and application forms this information were given in much more detail and revised annually, because, as I think the figures given here will show, something may be learned of the present position of the various sciences and their progress.

Also there are eighty-four members listed as headmasters which in itself is a very striking tribute to the growth of science as a school subject and to the wide interest in the Science Masters' Association.

The following abbreviations are used, as given in the annual report:

p. Physics Master.
c. Chemistry Master.
b. Biology Master.
m. Mathematics Master.
G. Geology Master.
gg. Geography Master.
gs. General Science Master.

Description	England	Scotland	Wales	Total
		One Subject		
p	265	1	13	279
c	279	3	16	298
b	35	—	1	36
m	31	—	1	32
gs	17	8	3	28
gg	4	—	—	4
G	1	—	—	1
	632	12	34	678

		Two Subjects		
pc	149	9	7	165
pm	90	—	8	98
cb	20	—	3	23
cm	17	1	5	23
cgs	17	—	2	19
pgs	10	—	—	10
cgg	7	1	2	10
mgs	6	2	—	8
pgg	5	—	—	5
bgs	4	1	—	5
cG	2	—	—	2
pG	2	—	—	2
ggG	2	—	—	2
mgg	1	—	—	1
gsgg	1	—	—	1
bgg	1	—	—	1
bG	1	—	—	1
	335	14	27	376
		Three Subjects		
pcm	36	2	3	41
pcb	15	—	1	16
pcgs	10	—	1	11
pcgg	8	—	—	8
cmgs	3	—	—	3
pmgs	2	1	—	3
bcgs	1	—	1	2
bcm	1	—	—	1
mGgg	1	—	—	1
cGgs	1	—	—	1
pmg	1	—	—	1
pcG	1	—	—	1
cbG	1	—	—	1
bcgg	1	—	—	1
	82	3	6	91
		Four Subjects		
pcbgs	6	2	—	8
pcgsm	3	1	—	4
cbgsm	1	—	—	1
pcmb	1	1	—	2
pcgsgg	1	—	—	1
	12	4	—	16
		Five Subjects		
pcmbgs	1	—	—	1
		Six Subjects		
pcmGbgs	1	—	—	1

The following are points of interest from these particulars:

(1) The great preponderance of physics and chemistry as school subjects, more so of the physics and chemistry combination. These made up considerably more than half the total number of school teachers considered and probably illustrate the influence of tradition.

(2) It is interesting to note the large number of one-subject science teachers, that is if the data is to be relied upon, but it is to be remembered that it is possible that only one science has been put down on the application form for membership even though several are being taught. In spite of this there is a quite surprising number of three-, four-, five- and even six-subject science teachers.

(3) Biology and general science, the newcomers in the school curriculum, make a poor showing of 36 and 28 respectively as totals for England, Wales and Scotland.

(4) The number of pure mathematics teachers is 32 which suggests rather a widespread interest in the activities of the Association.

(5) The combinations of sciences are extremely interesting and provide some food for thought for intending science teachers and suggest the warring influences of natural associations of the sciences and the expediency of the time table.

So far as general science is concerned, the special teaching of general science as a one-subject science is especially noticeable in Scotland where eight out of 12 are teaching general science. This is but one instance of what is apparent from these figures on a whole, that science teaching in Scotland is less akin to what is being done in England than Wales.

The general science figures are interesting. In England there are 17 people teaching general science exclusively, 38 teaching it with one other science, 17 with two other sciences, 11 with three others, one with four others and one with five others.

In Scotland there are 8 teaching general science alone, 3 general science with one other science, one with two others and one with three others.

In Wales three are teaching general science only, 2 general science and one other subject and 2 general science with two other subjects.

There are doubtless other points of interest from these details, but this may be left to the special interest of the reader. What must be emphasized is that the data cannot be regarded as reliable and that the figures show the existing situation qualitatively and the possible trend in development.

In conclusion, it is again emphasized that it would be useful to have correct data on subjects taught furnished by every member of the Science Masters' Association annually.

It is hoped to make a similar survey of women science teachers.

Individual and Group Projects in Chemistry

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At the end of each chapter of many of the present high-school-chemistry texts are listed among other things projects for *honor students*. While not wishing to criticize the authors of these texts for the worth while suggestions they make, it is the opinion of the writer that even the poorest student will be helped in his work if he works out a project of some kind either by himself or with a group of others. In the latter case, especially, the stimulation he will receive will be of lasting benefit.

In the *American Secondary Education Association Bulletin* for February, 1932, is given a list of such character objectives as pride in workmanship, satisfaction in achievement and self-reliance; such social objectives as interest in serving the general social welfare and coöperativeness; and such intellectual qualities as accurate observation, critical power, and imagination. In what ways will the carrying out of a special project aid in attaining these objectives?

When a student, after due reflection, chooses his problem and is told to go ahead, but that he should plan and execute it himself, he receives a lesson in self-reliance. When he does a good job he *knows it* with the resulting satisfaction in achievement and pride in his own workmanship. In doing the problem well he has had to make accurate observations and in laying out his work he must use his imagination. If accurately done, he is serving the general welfare, because the project in becoming the property of the department can be used in teaching others. In a group project he must learn to coöperate with others, a vital lesson which will serve him well in later life.

A year ago the writer had a boy in one of his classes, who seemed on his way to failing the subject. He was discouraged and felt that his chances of graduation with his class were gone. Knowing that he had excellent artistic ability, it was suggested that he work out some project where his drawing ability could be utilized. It was insisted that he select his own topic. After some thought and looking around he chose "Pyroxylin Plastics." Several weeks later he appeared with a wonderfully worked out chart showing not only the products but the raw materials and a lettered description of the processes from beginning to end. Moreover, he knew the processes and was proud of his job. It influenced his work so materially that there was no more question of his failing the subject. Was the project worth while?

At the present time one of our modern easy-going boys is making a model electric furnace. Although not a good science student, he likes to work in the manual training shop. From the questions he is asking and the reading he is doing concerning the types of furnaces, I know that he is going to do a good job. It is also influencing his class work for the better.

Last year one of our boys was interested in starting a home laboratory. Lack of money prevented him from buying a chemical balance. That did not stop him. He planned and made his own balance in the shop, using brass strips, iron wire, and aluminum pans. Its accuracy would surprise many a college student.

When three of our boys built a model contact sulphuric acid plant which worked, can any one question that they knew the process from beginning to end? If a boy makes some wooden models to show the shapes of various kinds of crystals, he must get some first hand knowledge of their form. When a girl makes some models of the simpler atoms or molecules, she must first study carefully the modern theories concerning atomic and molecular structure.

It is not the purpose of this paper to list all the possible projects which may be attempted but a list of those which our pupils have done or are at present carrying out is given below. For the benefit of those who might want further information on details of the projects, references to the *Journal of Chemical Education* are given where available.

1. Models

(a) Contact Sulphuric Acid Plant[1]
(b) Synthetic Nitric Acid and Apparatus[2]
(c) Frasch Process[3]
(d) City Water Purification and Softening Plant.
(e) Coke Plant[4]
(f) Liquid Ammonia[5]
(g) Water Softener[6]
(h) Lead Chamber Process[7]
(i) Atomic Models[8]
(j) Molecular Models[9]
(k) Airplane (showing importance of Chemistry in its construction)

2. Charts and Posters

(a) Coal Tar
(b) Plastics
(c) Bakelite
(d) Aluminum
(e) Copper
(f) Zinc
(g) Sulfur[10]
(h) Lead
(i) Air Products
(j) Hormones
(k) Vitamines
(l) Rubber
(m) Soap
(n) Nickel
(o) Monel Metal
(p) Alloys

3. Book-form Projects

(a) Antiseptics
(b) Karo
(c) Hydrogenation
(d) Paints
(e) Dyes
(f) Gases

4. Permanent Layouts for the Department

(a) Metals
(b) Alloys
(c) Compounds
(d) Ores
(e) Samples of Commercial Products

Worth while projects will: (1) aid in attaining the important objectives set up for the modern high school, (2) help to raise the standard of the students' scholarship, (3) furnish the department with material for future classes, (4) spur other students on to better work, (5) furnish material for exhibitions, (6) save money for use in other ways, (7) foster coöperation with other departments of the school, (8) show how chemistry is important industrially, (9) help pupils to learn how to look up material from various sources for themselves, and (10) enrich the course in chemistry very materially.

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[3] *Ibid.*, 8: p. 1385; 8: p. 1630.
[4] *Ibid.*, 6: p. 745.
[5] *Ibid.*, 8: p. 2062.
[6] *Ibid.*, 8: p. 1364.
[7] *Ibid.*, 7: p. 1668.
[8] *Ibid.*, 8: p. 140.
[9] *Ibid.*, 6: p. 1984.
[10] *Ibid.*, 8: p. 696.

A New Development in the Field of Objective Testing in Science

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It is the purpose of this article to present and discuss a new type of testing and instructional material which has been developed to overcome several defects or limitations of the more common types of tests now in use.

The history of the introduction and development of the various measuring instruments used in school subjects reveal a number of different types of testing techniques, each designed to overcome certain limitations of those which preceded it or to fit into certain phases of the testing or instructional program hitherto neglected, and each in turn being shown by later theory or research to possess certain limitations of its own. The written examination of the essay type was shown to be distinctly superior in many ways to the oral examination. Later developments of the theory of educational measurement, however, revealed two serious limitations of the essay-type examination, namely, its limited sampling and the lack of objectivity with which it could be scored. To meet these limitations the "new-type" or objective exercise was devised. An examination consisting of these new-type exercises could be made to contain more items and thus represent a more adequate sampling of the total field of instruction, and it could be made almost completely objective in scoring as well. Early use of these new-type exercises was made in the standardized tests which have been developed and are now available in almost all school subjects. Although standardized tests have overcome to a great extent the two serious faults of the essay-type examination, they in turn have certain inherent limitations.

In the first place, although the material in a standardized test may have been selected and validated by the best means available, the test may or may not be valid for a particular class. Common ways of validating test items for a particular subject are analyses of the best textbooks and courses of study, consideration of lists of objectives, experimental try-outs of the items, and comparison of the results obtained with other criteria of success or achievement in that subject. The use of such techniques may insure the validity of the test for the average class or for the majority of classes, but if the instruction in a certain class does not parallel the items in the test, or the materials or objectives used in its validation, the test will not be valid for that particular class. Furthermore, in a standardized test, the teacher has not any chance to strike out items not in his course or to add others

which he has emphasized, in order to improve the validity of the test for his class.

Another serious limitation of the usual standardized test is its lack of flexibility. Until recently the usual standardized test was designed to be of a general survey nature, to be given at the end of the year for the purpose of measuring and comparing achievement, and it could not be used effectively at any other time. Any other tests to be given at the end of six-weeks terms, at the end of a semester, or at various times and for different purposes during the term, must be constructed by the teacher.

The essay-type examination or the early standardized test was considered primarily a measurement device. The idea was prevalent that testing was something entirely separate from teaching—that every period devoted to testing decreased by that amount the time during which teaching and learning could take place. The test given at the end of the year was supposed to benefit the teacher and the supervisors and administrators of the system in the matter of assigning grades and determining promotion, but there was little in the test itself except the indirect motivation of the knowledge that an examination would be given, which would benefit the pupils. Furthermore, the results from such tests were obtained at a time when it was too late to do anything to benefit the pupils who were shown to be low in achievement.

The conviction that testing is not necessarily separate from, but is a part of, skillful teaching technique has been gradually growing. A test is of greatest value when it not only measures achievement, but does this at such a time and in such a way that the weaknesses revealed by the test can be remedied. Four types of tests of recent development evidence this change in attitude.

The first of the newer types of objective tests is the test designed to be given at the beginning of the term or year. It may be given primarily for the purpose of sectioning or classifying the pupils in ability groups. The *Iowa Placement Examinations*[1] are tests of this type. They may be given for the purpose of determining the mastery of certain fundamental skills or processes which will be needed in the subject, as in the case of the *Kilzer-Kirby Inventory Test on the Mathematics Needed for High School Physics*.[2] Another form of the inventory test is that used in spelling in order to determine how many of the words to be studied during the year the pupil can spell prior to study.

Another of the more modern types of standardized tests is the diagnostic test. The early standardized test was a survey test designed to be given at the end of the year to measure achievement. Any weaknesses or low levels of accomplishment revealed by such a test would not be discovered

until it was too late to do anything to remedy the deficiencies. The diagnostic test, on the other hand, is intended to be given sometime during the course, and to reveal not simply the general level of achievement, but also the specific reasons for poor performance. The fundamental weaknesses of the pupil in that subject will be discovered at such a time and in such a manner that suitable remedial work may be applied immediately. An example of a series of tests of this nature is the *Compass Diagnostic Tests in Arithmetic*.[3]

A third type of test which is coming into more general use is the unit or the instructional test. Rather than the single survey test to be given at the end of the course, a test is provided for each unit of subject matter. In case the test reveals a low level of achievement, more time can be spent on the unit before going on to the next one. The unit test may also be made definitely diagnostic in nature in order to more effectively guide remedial work. The amount of material covered in one of these tests may vary from a relatively narrow unit which requires only a few days class-time, to a much larger unit or division of the subject requiring a number of weeks. In the case of the *Glenn-Obourn Instructional Tests in Physics*[4] the units are relatively narrow, there being twenty-five tests over the year's work. The *Lane-Greene Unit-Achievement Tests in Plane Geometry*[5] are based on much wider units, such as The Circle, and Rectilinear Figures. There are six tests in this series for the year course. A somewhat different development of the unit test idea is the *Hurd Work-Test Book in Physics*.[6]

Although the foregoing three types of standardized tests represent important developments in the field of testing and disclose the fact that testing is not separate and distinct from teaching, but closely allied with it, they have not satisfactorily met the criteria of *validity* for a particular class and of *flexibility* of administration which have been shown to be desirable. Obviously no test could meet these requirements perfectly unless it were constructed by the classroom teacher himself. No one is a better judge than the teacher himself whether a certain item should be included in an examination over a certain section of subject matter as taught in his own class. No one should be better able than the teacher to tell when an examination should be given, how long it should be, and what and how much material it should cover. Because of these facts, a new type of teacher-made examination was developed in which the teacher himself was made responsible for the selection of the material to be covered by the test, the number of items to be included, and the statement of the exercises, but the form in which the exercises were stated was borrowed from the standardized tests. The questions, instead of being of the traditional-essay type, were stated as true-false statements, recall, multiple-choice and matching exercises, and

the like. These informal objective tests retained many of the advantages of the standardized tests; in general, they had high reliability; they took less pupil's time per item tested; they could be scored easily and objectively; and in addition, they overcame the two greatest limitations of the standardized test by making the teacher responsible for the validity of the test items and by permitting extreme flexibility of construction and use.

The construction and the use of informal objective tests in subjects for which they are suitable have become important techniques in many classrooms during recent years. However, there are several difficulties to be met in the construction of such tests. An objective examination is more difficult to construct than an essay examination. More skill is required in the statement of a single exercise in the case of the objective type. Since the answer is to be indicated by a single word or a mark properly placed, and the pupil has no opportunity to discuss or defend his answer, the question must be stated in such a way that there is no possible doubt as to its meaning. The exercise must not be stated in such a way that the answer is obvious or that clues to the correct answer are given. Considerable time is required to construct an objective examination because of the greater number of items involved and the greater difficulty of constructing the individual items. Unless great skill and care are exercised in constructing objective examinations, there is always a serious danger of making the items too factual, so that the ability to do well on the examination depends too largely upon sheer memorization of the isolated items in the textbook, rather than upon a reasoned understanding of their meaning or relationship or upon a comprehension of the subject being studied.

Because of these two factors, lack of time and limited skill, many teachers have not made as extensive use of the new-type examinations as they would have desired. Some teachers have partly overcome these difficulties by keeping their objective exercises from year to year, together with a record of the pupils' responses on them. By retaining those which proved satisfactory and revising others, or adding new ones to take their place, they have built up their own stock of tested exercises from which they can draw items for a quiz or examination whenever they need them. This results in a considerable saving of time, and insures that the exercises will be more nearly like those in a standardized test, in that they have been more carefully constructed and have been revised in the light of actual pupil reaction. Such private sets of objective exercises, however, do not benefit the beginning teacher, the teacher who has never made them out, or the teacher who changes textbooks or subjects frequently.

It seemed desirable, therefore, to develop a large number of carefully constructed and validated test exercises covering most or all of the im-

portant ideas and concepts of a subject and to make these available to the teachers of that subject as a source of material from which examinations, tests, and quizzes might be constructed. This material should be extensive enough to permit the teacher to select exercises which he considers valid for his particular course, and still have enough items for quizzes or tests over relatively narrow units of subject matter. The material should be so organized and classified as to facilitate the finding of test exercises over any particular concept or phase of the course. Such a set of exercises, if placed in a teacher's hands together with suggestions regarding their selection and use, would give him material comparable to that which an experienced teacher might have developed after several years of careful work in building up his own private set of test exercises in the way indicated in the preceding paragraph.

One such set of material which has been developed with the above idea in mind is the *Pupil-Teacher Handbook of Objective Test Exercises in High School Physics*.[7] In the construction of this handbook, seven of the most commonly used high school physics texts were analyzed in order to determine the concepts most frequently treated. All concepts common to at least five of the seven texts were selected. Objective exercises in true-false, multiple-choice, and recall form were constructed for the concepts. The exercises were arranged in units according to the sequence of content material in the various texts. A key number system was devised in order to facilitate finding and identification of the exercises. All of the exercises were tried out under actual classroom conditions before being accepted in their final form. The *Manual* which accompanies the *Handbook* gives a number of suggestions in regard to the way in which the material may be used in quizzes, reviews, and examinations.

The validity of an examination constructed from this material rests entirely in the teacher's hands. In the case of a standardized test, the particular course of study must parallel the test, or the test will be lacking in validity for that particular course. Although the test may have been constructed in such a way as to insure its validity for most courses or for the average course, it may have low validity for any one particular course. In constructing an examination from a handbook of objective test exercises, the teacher will select the exercises that are based on the concepts which he has emphasized in his own course. By pro-rating the items among the different units according to their relative importance or the relative emphasis which they have received in his course, and by selecting from the units the items which cover the concepts which he has stressed, the teacher may insure the validity of the examination for his particular course. Since the exercises included in the handbook have been selected on the basis of

textbook analyses, the examination constructed in this way will possess general validity as a test in that particular subject, as well as specific validity for the teacher's own course.

The reliability of such an examination is within the control of the teacher. Since the exercises are in objective form, the reliability of the examination constructed from this material is largely a function of the length of the examination and the extent to which it samples the major aspects of the subject.

In regard to the form in which the exercises are stated, and the objectivity with which they may be scored, the teacher has practically no responsibility. The authors of the handbooks are entirely responsible for seeing that ambiguous or indefinite or poorly-worded exercises are not presented. The teacher does not need to be able to construct good objective exercises, nor does he need to take the time to construct such exercises. His problem is simply that of selecting from the handbook those items which parallel his course and of using them in the form in which they are stated.

Up to this point, consideration has been given largely to the use of the handbook in the construction of term or final examinations. The form in which the material is presented also permits a flexible testing program as extensive as the teacher may desire. This testing program may be organized and the results used simply as an aid in measurement or in assigning grades, or it may be used primarily as an instructional device in which rather frequent tests are given for the purpose of motivation, of discovering pupil and class weaknesses, or of revealing to the pupils those aspects of the course which are considered by the teacher to be important. If the teacher wishes to give a short objective quiz over a single day's assignment, he may select items from the handbook over the material to be covered in less time than it would take to build his own exercises over the same material. If he wishes to give a quiz or a test over a week's work or two weeks' or a unit as presented in the handbook, or any other amount of subject matter, he may do this by selecting from the handbook exercises over the important concepts covered in that block of subject matter. If he wishes to build an inventory test to discover how much the pupils know about the material to be covered in any period, whether this be a single day's work or a semester, he may do this. If he wishes to discover whether the pupils have sufficiently mastered a certain section of subject matter before taking up the next section, or to point out exactly where the pupils' mastery is inadequate, he may do so. If he wishes to carry on a maintenance program based on review of important concepts at regular intervals, he may do this. A testing program, or a combined testing and instructional program, based on the use of this material, may be made as flexible and as extensive as the teacher desires

without requiring an excessive amount of time or skill in constructing the measuring instruments to be used.

With the material developed in this way it is obvious that the teacher will have no norms or standards for purposes of comparison, analysis, or guidance. There are situations in which such norms are desirable, and in such cases the use of standardized material would be necessary. A testing program based on the use of the handbook of objective test exercises should be considered as supplementing and not as displacing the use of other testing techniques. Probably no one single testing technique will ever be devised which will satisfactorily meet all the demands for measurement in any course. The standardized test in its various forms, the essay examination, the oral quiz, the informal objective examination, whether constructed by the teacher independently or by selecting items from some source such as the handbook, each will have distinct advantages over any of the other types in certain cases or when used for certain purposes, and each will have distinct limitations if used for certain other purposes. The handbook of objective test exercises has been developed to fit into certain places in the testing and instructional program, and to overcome certain limitations of the previously existing types of tests when used in these places. Although it, too, has its limitations and is not designed to eliminate the use of other testing techniques in certain phases of the testing program, it appears, on the basis of the experience of classroom teachers, to be a valuable addition to the testing materials now available, not only in physics but in the other physical and social sciences in which it has been developed.

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Research Studies Relating to the Teaching of Science

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New York University

In the first four numbers of volume sixteen of this journal, the author presented an extensive bibliography of investigations relating to the teaching of science. At that time it was attempted to list all studies which had been published prior to June, 1931.

The present bibliography is a supplement to the previous list and covers the period from June, 1931 to December, 1932, inclusive. The arrangement of the bibliography follows the general plan used in the earlier compilation of titles, and presented in outline in the October, 1931, issue of the journal. It should be understood that the arrangement is an arbitrary one, prepared for use in the compiler's course entitled "Investigations in the Teaching of Science." Only slight changes have been made in the division headings from those used in the former bibliography.

It was thought worth while to present in sections A, B, and C of the bibliography certain general references which have been found to be of value to those interested in research in this field. However, it should be clear that no attempt has been made to list here the numerous books, monographs and articles, published during the period from June, 1931, to December, 1932, and related to the problems of educational research in general.

The reader will observe that some studies under section D are not specific to the field of science education. All studies, however, are related to the teaching of science and throw direct light on the problems of science teaching. It will also be observed by some readers that certain studies which seem to be of little importance are included. It may be that such studies will suggest further research of great value and it is even possible that, in the light of future research, they may prove to be very significant *per se*.

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12. Supervision and Administration of Science Instruction

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Abstracts

General Education

LINDQUIST, R. D. "Developing a Functional Point of View." *North Central Association Quarterly* 7:304-306; December, 1932.

This article is a plea for more functional teaching units in the high-school curriculum. There have always been units of instruction in our high schools but the earlier units, i.e., divisions of the subject-matter field "failed to take into account the importance of the purpose of the learner as a force in integrating the various items of information and skill." Functional units will stress the social environment and the relations of the several subjects to this environment so as to help the pupil solve his own problems of social living. They will also encourage interest in specialization in the subject itself for those who find its study satisfying.

—A.W.H.

SYMONDS, P. M. "Characteristics of a Good Dissertation in Education." *Teachers College Record* 34:312-326; January, 1933.

Twenty-five good dissertations were analyzed "to determine those ways in which the good dissertations were alike and in which they differed from poor dissertations." The ratings of the dissertations were based upon the following nine characteristics: interpretation of data; fundamental assumptions considered and justified; evidences of ability; creativeness—originality; sound analysis of data; appropriativeness of procedures to the topic; presentation; the topic; and quality and quantity of data. There is also included a discussion relating to subject, content, procedure, presentation, and the document as a whole.

—C.M.P.

WEBB, P. E. "The Holding Power of Junior Colleges." *The Junior College Journal* 3:179-184; January, 1933.

The author analyzes the records of 12,022 students who entered thirty-one junior colleges of California in the autumns of 1928 and 1929. Of these, 55 per cent were men and 45 per cent, women. Of the 1928 entrants, 40 per cent, and of the 1929 entrants, 35 per cent were classified as of recommended status. The investigator concludes that about one-ninth of the students leave junior college before the end of the first semester and about 25 per cent leave before the close of the first year. Also, he finds that 46 per cent remain in junior college two years, 28 per cent graduate and 18.5 per cent of these graduates continue their education in another institution. "From the very beginning and continuously throughout the two years the ranks of non-recommended students are thinned more rapidly than are those of the recommended. While men and women maintain about their same relative percentages during the two years, a considerably higher percentage of women than of men graduate. The investigator concludes that "the evidence is overwhelming that the preparatory function of the junior college is not its primary one." He emphasizes the primary need for the survey type of course but recognizes also the desirability that vocational work "should have an important and dignified place." He further advocates an extension of the use of the comprehensive examination to replace the present more common use of examinations covering pre-professional, specialized technical courses.

—F.D.C.

BENJAMIN, HAROLD. "The Five-Year Curriculum for Prospective Secondary School Teachers." *Educational Administration and Supervision* 19:1-6; January, 1933.

Beginning with the thesis, "The present oversupply of persons legally qualified to teach, accompanied by the usual undersupply of competent teachers, is probably most noticeable on the secondary level," the author states that four outstanding solutions of this difficulty are being tried: (1) "More careful selection of entrants to the profession; (2) better measurement of the achievement of candidates for teaching; (3) improvement of the curriculum for prospective teachers; and (4) extension of the period of training." In his advocacy of the fourth plan, he urges a broader education than the present program provides—one which insures not only adequate preparation in subject matter and pedagogy and in a cultural background and outlook, but also better integration of professional courses, increased contact with practical school situations, and a careful evaluation of the quality of the product. —F.D.C.

ROEMER, JOSEPH. "Abstracts of Unpublished Masters' Theses in the Field of Secondary-School Administration." *Department of Secondary-School Principals of the National Education Association.* Bulletin No. 43, December, 1932.

In view of the fact that all of the theses are from one institution, the George Peabody College for Teachers, the general title on the cover page of this bulletin is decidedly misleading. Forty-three theses are abstracted. In addition, 141 other theses from the same institution are listed but not abstracted. The abstracted studies are grouped into fourteen classifications. These are: administration and supervision of secondary schools; status and training of teachers; extracurricular activities; tests and measurements; general methods of instruction; the junior high school; elimination and failures; history of education; population of the secondary school; foreign school systems; character education; vocational education; and surveys.

This summary will be of greatest value to those who are planning to carry on further investigations in this field.

—R.K.W.

ANDERSON, E. W. "Salaries in Certain Professions." *Educational Research Bulletin* (Ohio State) 12:1-9; January 11, 1933.

The article presents data relating to incomes in certain specific professions as medicine, dentistry, nursing, teaching, law, engineering, journalism, and investment banking. A table representing eight different studies is presented to show how the salaries of college graduates, who go into teaching, compare with the salaries of those who enter other professions. In seven of the eight studies listed, the college graduates who went into teaching were in the lower eighth of the groups studied; in three of the studies, teaching ranks at the bottom; in three others it is next to the bottom; in the seventh it is second from the bottom; in the eighth study all people in teaching are not lumped together, but those in public schools are twelfth out of thirteen professions and those in college teaching are sixth out of eleven professions. —C.M.P.

RICE, G. A. "Placement of Student Teachers." *University High School Journal* (California) 12:141-143; December, 1932.

The article discusses the problem of the placement of student teachers in the state of California. Data showing the extent of placement of student teachers are included.

—C.M.P.

MUNRO, W. B. "College and University Teaching." *Bulletin of the American Association of University Professors* 18: 533-548; December, 1932.

The article summarizes a committee report made to the Association of University Professors. The report is based upon a personal visitation to about fifty colleges by one of the members and the subsequent committee discussion. The following questions and topics are discussed in the report: What is good teaching?; Are criteria of good teaching practicable?; Recruiting the profession; Present facilities

for the selection of teachers; Relation of teaching to research; Rating by students and alumni; Courses in education as a part of the college teacher's preparation; The newer methods of teaching; and Experiments in the technique of teaching.

—C.M.P.

WITMER, ELEANOR M., and MILLER, MARGARET C. "U. S. Office of Education Serial Publications." *Teachers College Record* 34:302-311; January, 1933.

A check list with descriptive notes of the various publications of the United States Office of Education is presented by the authors. Dates covered by the publications are included. —C.M.P.

CARROLL, R. P. "Factors That Make a Subject or Course Difficult." *Educational Method* 11:491-494; May, 1932.

Some of the important extrinsic factors causing a subject to be difficult are: (1) Dislike for the teacher; (2) Wrong attitude toward a subject, school, etc.; (3) Poor teaching methods; (4) Haphazard and indefinite reviews; (5) Poor organization of the course; (6) Newness of the subject; (7) Poor method of study; (8) Deficient background; (9) Lack of self-confidence; and (10) Amount of material to be covered.

A teacher's attitude towards a child, indicating dislike, usually has a very harmful effect.

Technicality, in the broader sense, involves definite types of procedure, the consideration of cause and effect or sequential relationships, and the application of scientific rules or laws. It is found in mathematics, sentence structure, composition, poetry, drama, music, art, mechanics, and the sciences. The habit of reasoning should be developed more generally and to a greater extent in school children. More "thought" questions and less rote memory questions should be given in the different school subjects. Another suggestion is that courses including too much technical work should be broken up and distributed over longer learning periods, the various units being supplemented with more exercises, laboratory work, or illustrative material. The more highly technical work should be given only to those of superior intelligence or to those of the more advanced mental ages.

Exactness is listed as another factor that makes a subject hard. Perhaps habit has a great deal to do with this, for we are more inclined to think in loose, general terms than to be specific and definite.

Some subjects are too compact. It might be more nearly correct to say that they are too compact as presented in school courses or textbooks. This is especially true of mathematics and the sciences. Taking some of these subjects as they are now given is too much like living on a single diet of cheese, with no bread, fruit, or vegetables included. As the student proceeds in physics and chemistry, there is too little opportunity for application of what is supposed to be learned. It is too much a matter of "stuffing down" a lot of hard-packed, congested facts or principles, the main idea being to "cover" a great quantity of material. —G.S.C.

Symposium. "American Education Viewed by European Eyes." *The Harvard Teachers Record* 3:7-46; February, 1933.

Four European educators, Sir John Adams of Scotland, Robert Ulich of Germany, A. Desclos of France, and Paul L. Dengler of Austria contrast and compare American education with education in their own schools. The viewpoints are expressed in the following articles: "A Briton Looks on American Education," by Sir John Adams; "The Structure of the American Educational System as Seen by a German," by Robert Ulich; "American Education as Seen Hurriedly by a Frenchman," by A. Desclos; and "Spiritual Life in a Technical Age: Observations of an Austrian Visitor," by Paul L. Dengler.

These articles have been the subject of wide comment. As a whole the articles indicate a sympathetic understanding of, and a penetrating insight into, our unique American education. The one great criticism would seem to be our tendency toward superficiality. Many commendable things are said by these visitors who base their comments on extensive personal visitations to many American schools.

—C.M.P.

Science Education in General

CALDWELL, O. W. "Science—Truth and Propaganda." *School Science and Mathematics* 33:26-33; January, 1933.

A penetrating and stimulating analysis of various phases of present-day science education. The keynote of the discussion is summed up in this thesis, "Possibly our greatest need is not more universal assent to the findings of science but assimilation of science into our habits of action."

—F.D.C.

HURD, A. W. "Appreciational Objectives of Science Teaching." *School and Society* 37:124-125; January 28, 1933.

A report of an investigation to determine the extent to which high school pupils studying science are cognizant of certain appreciational concepts. An original list of 137 appreciational objectives obtained from writings of educators in the field of science teaching were submitted to members of the New York Physics Club and to students pursuing graduate courses in Teachers College, Columbia University. Subsequently the items were made into two forms of a true-false test, each containing 64 items. Form A of the test was given to general science, biology, physics and chemistry students in the Peoria, Illinois, High School. Form B of the test was given four months later. The author concludes that certain statements involving appreciations in high-school science are not obvious to all high-school students and that considerable gains result from specific instruction in appreciational objectives.

—C.M.P.

KIMBALL, D. S. "The Social Effects of Mass Production." *Science* 77:1-7; January 6, 1933.

The article discusses the social effect of the mechanization of the processes of industry. Several illustrations are given to show the extent to which machines have replaced men. However, in a majority of these cases, this replacement of men by machines has been in industries that are the products of science and machines. Technological unemployment is not necessarily a product of mass production, but rather due to our antequated economic system, especially as it relates to distribution. Mass production is having, and will continue to have, a tremendous effect upon social economy and social philosophy.

—C.M.P.

Science in Elementary Schools

BUSH, SHEPHERDS. "A Suggestive Scheme of Nature Study for a Junior Mixed School." *School Nature Study* 27:116-117.

In publishing a new series of schemes of work in nature study, the Committee of the School Nature Study Union (England) has taken note of recent developments in school organization which have resulted in the grouping of pupils into junior elementary, senior elementary, central and secondary departments. The Committee have responded to modern tendencies in nature-study teaching in England with its marked biological bias. No single scheme, however, carefully compiled, would meet the needs of all. Nor is it, in the estimation of the Committee, desirable that teachers should adopt a ready-made syllabus for their courses of lessons. They prefer that the proposed scheme be an expression of the opportunities, interests and aspirations of each school.

The Committee contends that nature study must be scientific in character and must, therefore, deal with real and concrete things which are accessible to the pupils and which excite interest, develop the habit of accurate observation and stimulate reflection and reasoning. The spirit of inquiry must be kept alive and ample scope for investigation and experiment must be provided. Mr. Bush contends:

1. A nature lesson should be largely "sketch and describe." It should assist spelling, composition and drawing. Accuracy of detail, however, rather than pictorial effect should be the aim of nature study drawing.

2. As a rule, a specimen should be provided for each pair of children.

3. Good nature study should lead at least some of the pupils to undertake original observations.

4. Earth lore is intended as a foundation for intelligent geography teaching.

A course of study is given for the winter and summer terms in earth lore, plant and animal life for children eight to ten years of age. Some of the topics for study that are listed are: observation lessons on rocks, fossils, bulbs, fruits, toadstools, mammals, worms, germination, flowers and fertilization, and pond animals. The topics are largely lists of observations and studies of objects.

This entire article will interest elementary school writers because it gives opportunity to compare the English and American practices. —G.S.C.

WHITE, W. J. "General Outline Scheme of Indoor Work." *School Nature Study* 27: 117-118.

The work is designed in the junior departments to arouse interest by simple experiment and careful observation and, in the middle departments, to develop a spirit of scientific inquiry into plant and animal functions, processes and atmospheric phenomena. A recognition is made in the senior department of the importance of a profitable means of employing leisure in a rural area. The outside activities recommended by this headmaster for a school in Somerset, England, are gardening, visits to farms, nurseries, and apiaries, and keeping livestock. —G.S.C.

KILLICK, A. E. "Observations on Science Syllabus." *School Nature Study* 27:118-120.

The author of this article is the Headmistress of the Highway J. G. School, England.

The main ideas behind the formation of this syllabus are: (1) The inter-connections of the many branches of nature study, sufficient of which are included to illustrate this; (2) The fundamental necessities of light and air for every living thing; (3) The value of basing each year's work upon that of the previous year; and (4) The building of a foundation of more serious biological study later.

This syllabus lists studies and activities for children of ages seven to eleven for the following divisions: plant life, animal life, including human physiology, and general science, including hygiene. This outline includes such topics as, seasonal change, apparent movements of the sun, personal hygiene, the atmosphere, ventilation, wind, sun, respiration, dispersal of seeds, animals and their environment, the magnet, pollination and sky study. Apparently, the author has attempted to develop a well-balanced program. It represents a recent development in science education in the elementary schools in England. —G.S.C.

WRIGHTSONE, J. WAYNE. "Fur Bearing Animals—An Integrated Unit in Natural Science." *The Grade Teacher* 50:348-349.

This is a report of a science unit for fourth grade. The theme control is "Increasing interdependence of one group upon another, both in human and in animal life, has been a leading principle of social and natural sciences." The report of the unit includes an account of aspects and objectives, information for the teacher, suggested approaches, references and assimilative material for the teacher. The objectives listed indicate a recognition of the value of the important generalizations and meanings of science to the organization of a unit in science in the elementary school. —G.S.C.

PALMER, E. LAURENCE. "Light." *Cornell Rural School Leaflet* 26:3-43; January, 1933.

Although intended for the elementary teacher, this leaflet contains much information relating to light that may be useful to the teacher of general science, physics and home economics. Consideration is given to the following: the nature of light; results from reflecting light; the refraction of light; the spectrum; diffraction and interference in light; sources of light; lenses; light and heat; light and food; light and health; and optical illusions. —C.M.P.

Science in Grades Seven, Eight, and Nine

MAYFIELD, JOHN C. "The Systematic Development of Learning Units in General Science." *School Science and Mathematics* 33:40-52; January, 1933.

This is the second article of a series, the first of which appeared in the March, 1932, issue of the same magazine. In this paper, the author gives careful direction, with ample illustrations, for trial and revision of units in the general science course. —F.D.C.

BOSSING, E. W. "The Micro-Projector as an Aid in the Teaching of Biology and General Science." *School Science and Mathematics* 32:1008-1014; December, 1932.

A valuable article giving many practical suggestions for the use of the microprojector in providing visual aids for teaching purposes, motivation, and enrichment. —F.D.C.

Moss, H. V. "Reinforcing a Weak Spot in Our Diet." *Scientific American* 148: 90-91; February, 1933.

Science seems to have definitely established that the body requires at least eleven inorganic elements. Most of these elements are required in extremely small amounts. The average human body contains iodine to about four-hundred-thousandths of one per cent. Copper is necessary in order that the body may utilize the iron of which the body needs about .015 grams a day. We need about .68 grams of calcium and 1.32 grams of phosphorus daily. Inorganic salts or phosphorus seem to be as valuable in our diet as the organic compounds. Experiments seem to indicate that many necessary inorganic elements may be added to many commonly-eaten foods without detriment to the properties of the latter, such as taste, keeping properties, and so on. The inorganic elements that seem to be necessary are: calcium, phosphorus, iron, copper, magnesium, sodium, potassium, chlorine, sulfur, and possibly also cobalt, nickel, fluorine, silicon, zinc, and even arsenic. —C.M.P.

Science in Senior High School

Symposium. "Achievements in 1932." *Science News Letter* 22: 399-410; December 24, 1932.

The most important scientific achievements during the year of 1932 are outlined in this symposium. Ten outstanding groups of science achievements are listed, followed by a group of important achievements in each of the fields, namely Aeronautics, Anthropology and Archaeology, Astronomy, Biology, Chemistry, Engineering, Geology and Geography, Medicine, Physics, and Psychology.—C.M.P.

BLANK, KERMIT J. "Improving Reading in Biology." *School Science and Mathematics* 32:889-892; November, 1932.

A practical exposition of a carefully planned program of remedial work devised to secure faster reading of biological materials with increased comprehension. The plan includes four steps: (1) a measurement of the reading rate and comprehension of pupils at the beginning of the term; (2) a diagnosis based upon the results of these measurements, for the purpose of discovering both the individuals who most need help and the sort of help needed; (3) remedial measures and (4) measurement of improvement. The remedial measures include study helps, outlines, special reports to be given by those whose comprehension was low, thought provoking questions, short tests to stimulate reading and thought, topic indentions of main points treated in certain paragraphs, and devices used for increasing rate of reading. This last included (1) stimulation to read interesting supplementary material in books and magazines, and (2) questions encouraging speed competitions in finding in the text the answers to questions. This remedial program accomplished substantial gains both in reading rate and comprehension. —F. D. C.

FRANKLIN, G. T. "A Common Sense Basis of Chemistry Teaching in Secondary Schools." *School Science and Mathematics* 32:857-862; November, 1932.

A discussion of the individual and the demonstration plans of laboratory work in chemistry with conclusions and generalizations chiefly based upon the author's experience as a teacher. —F. D. C.

Symposium. "The Phosphorous Family." *The Chemistry Leaflet* 6:1-32; November 24, 1932.

The members of the phosphorous family are discussed. Many new and interesting facts not commonly found in textbooks are brought to light. —C. M. P.

Symposium. "Breakfast, Luncheon and Dinner." *The Chemistry Leaflet* 6:1-32; November 17, 1932.

An interesting series of articles relating to the chemistry of food in the home. vitamins, and nutrition. —C. M. P.

FINK, COLIN G. "Electricity, the Modern Handmaid of Chemistry." *Scientific Monthly* 35:449-451, November, 1932.

The author enumerates ways in which electricity makes possible chemical processes otherwise very difficult to bring about. —C. M. P.

Symposium. "The Importance of Chemistry in America." *The Chemistry Leaflet* 6:1-32; October 6, 1932.

An interesting account of the history of chemistry in the United States. Approximately one-half of the issue is devoted to the recent developments in chemistry, with major emphasis on the importance of chemistry in modern life. —C. M. P.

COONTZ, JOHN L. "Find Mysterious Error in Speed of Light." *Popular Science Monthly* 121:36-37; December, 1932.

This illustrated article describes the late Professor Michelson's last determination of the velocity of light. For reasons as yet unexplainable, there was found a discrepancy of fifteen miles per second as compared with the former determination. Careful check of the apparatus has failed to throw any light upon the reason for this difference. —C. M. P.

Anonymous: "Wonders of Man-made Lightning." *Popular Mechanics* 59:226-230; 122 A; February, 1933.

This illustrated article describes several experiments carried out with high frequency and high voltage generators. —C.M.P.

Symposium. "The Silicon and Boron Families." *The Chemistry Leaflet* 6:1-32; January 5, 1933.

This issue describes many of the uses and compounds of silicon and boron. Interesting sections are devoted to the quarrying of granite, the background and development of glass manufacture, and the evolution of the microscope. —C.M.P.

Symposium. "Products of Chemical Synthesis." *The Chemistry Leaflet*. 6:1-32; December 15, 1932.

Many interesting synthetic processes are described in this issue, some of which refer to bakelite and other plastics, various methods of making paper from cellulose, masonite, and rayon. —C.M.P.

Symposium. "Cloth." *The Chemistry Leaflet* 6:1-32; December 29, 1932.

The general process of manufacturing cotton goods from ginning to the bleached and dyed finished product is set forth. Considerable attention is paid to the various processes of manufacturing rayon and also to the history of the dye industry. This leaflet is illustrated. —C.M.P.

ALLISON, FRED. "The Magneto-Optic Method of Analysis." *Journal of Chemical Education* 10:71-78; February, 1933.

The article describes the author's magneto-optic method of analysis, with special reference to the detection of elements 85 (Alabamine) and 87 (Virginium) and the heavy isotope of hydrogen. Elements 85 and 87 have been detected in various substances. The method is able to detect compounds in concentrations as small as one part in 10^{11}. —C.M.P.

COMPTON, A. H. "A Geographic Study of Cosmic Rays." *The Scientific Monthly* 36:75-87; January, 1933.

The article summarizes the various theories held as to the origin of cosmic rays and describes the recent world survey made by Compton and his associates. Compton does not share Millikan's belief regarding the origin of cosmic rays and in this article he presents some of his evidence for disagreeing with Millikan. (*Abstractor's note:* One of the high lights of the recent Atlantic City meeting of the American Association for the Advancement of Science was the controversy between Compton and Millikan as to the origin of cosmic rays.) —C.M.P.

LANGER, R. M. "Cosmic Rays are Photons Dr. Millikan Declares." *Science News Letter* 22:384-385; December 17, 1932.

Latest observations were made by Dr. Millikan at great altitudes in an effort to secure information regarding the origin of cosmic rays. Dr. Millikan comes to the conclusion that these penetrating radiations originate in interstellar space.—C.M.P.

PEARSON, T. GILBERT, and BROOKS, MAJOR ALLAN. "Crows, Magpies and Jays." *The National Geographic Magazine* 63:51-79; January, 1933.

This is the third of a comprehensive series of descriptions and paintings of all the important families of birds of North America. There are sixteen illustrations and seventeen portraits in color. Opposite each portrait is a description of the bird portrayed. —C.M.P.

BAILER, J. D. "Variations in the Prices of Metals in the Last Twenty Years." *Journal of Chemical Education* 10:99-107; February, 1933.

Wars and depressions affect the prices of metals very greatly. Iron and steel markets follow the economic development of the country more closely than do the markets of the other metals. The prices of some metals reached the lowest price in history during the past two years. Eight graphs showing the fluctuations in the price of several metals are included.

—C.M.P.

New publications

KALLET, ARTHUR, and SCHLINK, F. J. *100,000,000 Guinea Pigs.* New York: The Vanguard Press, 1933. 312 p. $2.00.

What an unusual title for a book! Most of us would not have "guessed" that there were that many guinea pigs in the whole world! There probably are not of the kind you are thinking about! You and I, and every other consumer, have been forced into the rôle of laboratory guinea pigs through our use of widely advertized foods, drugs, and cosmetics, or so maintain the authors. Quoting from page 6 "and the law gives them (the manufacturers of food, drugs and cosmetics) the right to experiment on the public whatever the consequences to the human beings involved. In the eyes of the laws we are all guinea pigs, and any scoundrel who takes it into his head to enter the drug or food business can experiment on us. He may be uneducated, even feeble-minded. If he decides to become a manufacturer, it is his privilege to take down a dozen bottles from the shelf, mix their contents together, advertize the mixture as a remedy for indigestion, or asthma, or coughs, and persuade us to buy it. The mixture may contain strychnine, arsenic, carbolic acid, and other deadly poisons. But—in most States—he will have violated no law, indeed will not have offended the ethical sense of the average judge or legislator." Science teachers, especially biology and general science teachers, as well as science textbook writers and others who have lauded the Food and Drug Act, may well read this book. It may change their beliefs!

This book points out the dangers in everyday foods, drugs, and cosmetics. Many either contain deadly poisons or are absolutely worthless for the purposes advertized. Dangerous bacteria in antiseptics; germicides that don't kill germs; a common breakfast food that is, for many, a powerful intestinal irritant; poisons in a dozen common cosmetics; sub-standard ether daily endangering lives of patients in major operations in dozens of hospitals; deadly arsenic on nice juicy apples; a well-known tooth-paste containing sufficient poison to kill a person—these and many other dangerous materials are described, not to mention the still greater list of harmless but worthless foods, drugs, and cosmetics so highly advertized.

This book states names and the reader is not left in the dark as to what foods, drugs, and cosmetics are being described. Evidently the authors (and the publishers) have the facts or they would not dare to publish what is described. Mr. Kallet is an engineer and member of the board of directors of Consumer's Research, Inc. (an organization quite familiar to many of our readers). Mr. Schlink spent six years as research engineer and physicist in the United States Bureau of Standards and is Technical Director of Consumer's Research, Inc. —C.M.P.

MAXWELL, PAUL A. *Cultural Natural Science for the Junior High School.* Baltimore: The Williams and Wilkins Co., 1932. 80 p. $2.00.

This study attempts to evaluate curriculum materials for junior-high-school students of general science in terms of their cultural values. The specific objectives of cultural natural science are defined by Dr. Maxwell as "growths in desire and abil-

ity to achieve pleasant and wholesome diversions through the appreciation of natural science themes." The argument for this position is forcefully set forth in an introduction by Dr. David Snedden.

The specific aim of the research is to formulate a list of approximately 100 "themes" or topics from the field of science each of which, according to the opinions of competent judges, shall have high cultural value for junior-high-school students.

Criteria for selecting themes to provide a preliminary list were formulated in order to insure (1) that a proper range was covered, (2) that qualities pertinent to the cultural emphasis were not overlooked and that each theme should have them in some measure, (3) that each theme should have a proper scope, and (4) that the wording should be such as to suggest curriculum material and be properly interpreted by judges. From an examination of 12,528 titles, mainly popular science books and magazine articles, a list of 421 themes was prepared. The list was then submitted to sixteen carefully selected judges for evaluation. Each judge is either an accepted leader in the field of secondary-school science education and teacher training, or holds an important editorial position in connection with a leading popular scientific magazine. Thus the judges combine a knowledge of what is suitable for junior-high-school children with an understanding of what sort of science appeals to the general layman.

The topics were rated into three groups by the judges. Each group was then arbitrarily given a number and a composite rating obtained. The reliability of the rating was determined by correlating the evaluations of various groupings of the judges and using the Pearson prediction formula. —O. E. UNDERHILL

KELLEY, TRUMAN LEE. *Scientific Method, Its Function in Research and Education.* New York: The Macmillan Company, 1932. 233 p. $1.50.

This volume is useful for workers in the social sciences, especially for those people interested in the scientific attack upon problems in the field of education. It consists of a series of lectures delivered by the author. Five of the nine were delivered in the Graduate School of Ohio State University in 1928. Others are lectures given to different organizations at varying times. There is no single theme of continuity running through the whole series. This has the possible advantage that single chapters may be read in isolation from the others.

Titles are as follows: Inter-relationship between Method of Research and Field of Investigation; The Rôle of Judgment in "Objective Measurement"; What Purposes Are Served by Scales of Mental Measurement; The Objective Measurement of the Outcomes of the Social Studies; The Scientific Versus the Philosophic Approach to the Novel Problem; A Defense of Science in Education; The Conference Method of Finding the Truth; The Bearing of Recent Scientific Development upon the Problems of Education and Inheritance; Mental Traits of Men of Science.

The book is recommended to students of education contemplating research and to those directing research. It is especially to be recommended for reading by the critics of modern attempts at scientific research in the field of education.

—R.K.W.

BEEBE, WILLIAM. *Nonsuch: Land of Water.* New York: Brewer, Warren and Putnam, 1932. 252 p. $3.50.

Nonsuch is a record of observations on the plant and animal life and the geology of Nonsuch Island near the Bermudas. It is far more, however, than a mere record of description. It is an interpretative record in which the observations are strung like beautiful and vari-colored beads upon a thread of integrating background of biological principle and hypothesis. It is just this difference which sets this type of book so far above most of the nature materials prepared for supplementary reading for school children. So much of this latter type of material is observation for its own sake. *Nonsuch* is observation made meaningful.

The first chapter discusses "Mount Bermuda" and something of its geological

history; the second chapter gives an interesting account of the adaptive activities of the wind-blown cedars of *Nonsuch;* the third chapter, "Almost Island," deals with the flora and fauna on and around the slopes of this hill-top which is not quite tall enough to poke its head out of water and become an honest-to-goodness island. The remaining chapters deal with interesting aspects of flying fish and their sargassum-berry-resembling young, various bird studies, crabs, snails, and the like.

The author combines with his great enthusiasm and literary skill, the accurate knowledge and method of thought of the scientist. This is a book for young and old, scientist and layman alike.

—O. E. UNDERHILL

BENJAMIN, HAROLD. *An Introduction to Human Problems.* Cambridge: Houghton Mifflin Company, 1930. 472 p. $2.75.

This book is an exceedingly ambitious attempt to survey the growth and change in human problem-solving within very compact space limitations. It is intended as a text for the orientation of freshman college students. The content includes an introduction presenting man as a problem solver; a description of the development of scientific method, illustrated with cases from the natural sciences; a section on biology, chiefly evolution and heredity; a section on psychology, its methods and problems; a treatment of the major social sciences, history, sociology, economics, and political science; a section on social change and social progress; two chapters dealing with æsthetics, including the dance, music, painting, language arts, sculpture and architecture; three chapters dealing with problems of religion and the supernatural; and a final summary chapter.

There is no attempt to present details of subject matter of the various fields of human endeavor. A clear picture of the origins, chief methods, and changes in ideas and methods of each field is presented. The style is narrative rather than descriptive and the reading is easy and attractive. There are few technical terms. Well-chosen readings supplement each chapter. A specialist looking for new things in his field will not find them. He may gain a clearer conception of the setting of his field in relation to the work of others. The book should offer an improvement in orientation courses over those courses dealing with broken fragments of special subjects. Its reading is recommended to busy laymen, teachers of natural and social sciences, as well as to the freshmen who may use it as a text. —R.K.W.

PATCH, EDITH M. and HOWE, HARRISON E. *Nature and Science Readers.* Book I —*Hunting,* 161 p. $.80. Book II—*Outdoor Visits.* 212 p. $.84. New York: The Macmillan Company, 1932.

The authors introduce boys and girls to many common plants and animals by means of visits to field, school garden, park, and zoo. On these trips the children observe and talk about the homes of living things, their food, care of young, how they live over the winter, how they protect themselves, leaf coloration, leaf fall, flower visitors, seed distribution, and how to care for plants in park and garden.

The books are profusely illustrated by excellent drawings in black and white and by many full-page pictures in color. Each picture has a significant relationship to the ideas expressed in the textual material. Activities are suggested for each unit by such headings as: "What do you remember?," "Choose the right word," and "What is it?" The vocabulary has been checked with the vocabulary lists of Gates and of Thorndike.

These books are written in dignified and direct style and are accurate in content. They are a valuable contribution to science literature for the early elementary grades.

—F.G.B.

Teachers' Lesson Unit Series. Edited by William A. McCall and Lelah M. Crabbs. New York: Bureau of Publications, Teachers College, Columbia University. $.25 each.

The *Teachers' Lesson Unit* series will eventually consist of hundreds of units relating to the various subject-matter fields. These units range from pre-school through the college levels. They are contributed by successful teachers in various parts of the country. They are exact ac-

counts of lessons that show how modern educational theory is being applied in actual teaching situations. In addition, they offer helps to teachers in the way of suggestive activities and reading materials for pupils and a bibliography for teachers. The units are published in the form of paper-bound booklets ranging in size from twelve to fifty pages with the price varying from twenty to twenty-five cents each. Sixty lesson units are now available. A few of the splendid booklets are: *The Story of Wool, A Fair and Study of Milk, A Grocery Store, The Story of Lighting, Astronomy, The Byrd Antarctic Expedition, Trees, Creatures of the Sea, Parks, The Radio Enters the Classroom, Home Economics Without a Laboratory, An Old English Christmas,* and *Egypt*.—F.G.B.

WRIGHT, HELENA. *The Story of Sex*. New York: The Vanguard Press, 1932. 167 p. $2.00.

In *The Story of Sex* the author traces the process of reproduction in plants and animals, including man, and begins with the simplest form of reproduction, that of cell division in unicellular plants and animals and briefly describes the increasing complexity of reproduction as it culminates in higher plants and animals. Considerable attention is devoted to the psychological development of sex instinct and its control. There is an introduction by Dr. Paul Popenoe of *The Institute of Family Relations of Los Angeles, California*.

—C.M.P.

READ, THOMAS T. *Our Mineral Civilization*. Baltimore: The Williams and Wilkins Company, 1932. 165 p. $1.00.

Another volume has been added to the excellent *Century of Progress* Series in science. In many respects this is one of the most interesting that has been reviewed. It is a fascinating story of how man is utilizing minerals to augment his natural capacities. While not a statistical compendium, the present work is crammed from cover to cover with an array of facts which emphasizes the propriety of calling ours a "mineral civilization." "There is not a single mineral substance of which the quantity used in the last century is less than the total of all the centuries that preceded." Although we have been utilizing minerals in enormous quantities, our present capacity to consume them is far below our ability to make them available. However, this condition is likely to be reversed in the not-so-distant future, and the question of an adequate supply of easily available minerals will prove to be the greatest social and economic problem of the day.

While it is an excellent treatise for lay readers and all science teachers, teachers of chemistry and geography will find the book especially valuable. —C.M.P.

HODGMAN, CHARLES D. *Handbook of Chemistry and Physics*. Cleveland: Chemical Rubber Publishing Company, 1932. 1722 p. $6.00. ($3.00 to students.)

This publication is a veritable Bible to students and teachers of chemistry and physics. Its popularity is attested by the fact that this is the seventeenth revised edition. All material has been brought up-to-date and considerable new material has been added. Many tables are found under each of these larger headings: Mathematical Tables, General Chemical Tables, Properties of Matter, Heat, Hygrometric and Barometric Tables, Sound, Electricity and Magnetism, Light, Measures and Units, Wire Tables, Definitions and Formulæ and Miscellaneous Tables.

The encyclopedia of physical facts, formulæ, constants, and information is scientifically accurate and so arranged as to greatly enhance its usefulness. If you want to know the formula of sulfobenzeneazoaminonaphthalene, the heat of formation and the heat of solution of selenic acid, the magnetic declination for (Avilla) Indiana, the logarithm of 714, the hysteresis of steel, and the thousand other more or less common questions arising in the field of chemistry and physics, here is the book that will supply the needed information.

—C.M.P.

WELLS, H. G., HUXLEY, JULIAN S., and WELLS, G. P. *The Human Mind and the Behavior of Man*. New York: Doubleday, Doran and Company, 1932. 165 p. $1.00.

This small volume is a section taken di-

rectly from the larger *Science of Life*. The paging follows that of the larger editions from which this is taken as an excerpt. This particular part contains pages 1270 to 1435 of the complete work. Publication in this form makes it possible for readers, who are especially interested in this one phase of the "outline of life," to purchase it economically and in convenient form.

The subject matter treated consists in the main of material customarily given under the head of psychology. There is also a brief treatment of the scientific merits of spiritualism. Divisions are classified under such headings as consciousness; the brain; the cortex of work; human behavior and mind; modern ideas of conduct; and borderland science. As with other surveys of fields of knowledge, the individual trained in psychology will gain little from this summary. The layman wondering just what the field may contain should find what he is seeking here. —R.K.W.

WELLS, H. G., HUXLEY, JULIAN S., and WELLS, G. P. *Evolution, Fact and Theory*. New York: Doubleday, Doran and Company, 1932. 329 p. $1.00.

This is a second excerpt from *The Science of Life*. This part contains pages 314 to 643 of the original. For those interested in the material dealing with evolution only, this will be a welcome volume.

Topics treated are: Evolution and Creation; The Nature of the Proof of Evolution; The Evidence of the Rocks; The Evidence from Plant and Animal Structure; The Evidence from the Variation and Distribution of Living Things; The Evolution of Man; The Essence of the Controversies About Evolution; The Variation of Species; Selection in Evolution; Is There a Mystic Evolutionary Urge.

For most amateur readers in biology this is probably the most interesting part of the "outline of life." It is difficult to stop at any particular spot after having once begun. Illustrations are numerous and apt. Misinterpretations of evolutionary theories are well-treated. It is to be hoped that many laymen will find occasion to unravel their own thinking on the matter of what the scientists mean by evolution through the perusal of this little book.—R.K.W.

WELLS, H. G., HUXLEY, JULIAN S., and WELLS, G. P. *Reproduction, Genetics and the Development of Sex*. New York: Doubleday, Doran and Company, 1932. 139 p. $1.00.

This is a third excerpt from *The Science of Life*. This section contains pages 436 to 575 of the original. It is not in any sense a treatise on human sexual relations but an interpretation of the problems of reproduction and heredity as these affect life in general.

Major topics treated are: Spontaneous Generation; Sexless Reproduction; Regeneration; The Mechanism of Inheritance; Different Kinds of Variation; Mendel's Laws; Genes and Chromosomes; Plant Breeding; Common Superstitions about Heredity; Normal and Monstrous Development; The Limitation and Control of Growth; Age, Retrogression and Rejuvenation; Is Human Rejuvenation Desirable; The Normal Causation of Sex; Can We Control the Sex of Our Children; Sex Hormones.

Much malpractice and quackery could be prevented and many superstitions eradicated if the average layman and his wife would familiarize themselves with the contents of this small volume. —R.K.W.

BAGLEY, WILLIAM C. and MACDONALD, MARION E. *Standard Practices in Teaching*. New York: The Macmillan Company, 1932. 189 p. $2.00.

The authors state in the preface that the aim of the book is "to present in a terse, summary form the standards that should govern various procedures in teaching in so far as there is general agreement upon these standards among competent students of the problem, competent teachers in the service, and particularly among those who advocate this or that procedure." The treatment is brief, clear and often dogmatic. The authors so state their position that one is not left to wonder as to what are their beliefs regarding a certain teaching procedure. They admit there are some who will disagree with certain positions they have taken, and lament the fact that so few standards in teaching have been firmly established by controlled experiment.

The topics discussed include: The Suc-

cessful Teacher; The Teacher's Personality; Class Management; Planning; The Assignment; Directing Study; Questions and Questioning; The Topical Recitation; The Project Method; Teaching Through Activities; Teaching Large Units; Teaching for Appreciation; Individual Instruction or Self-Instruction; Drill; The Review Process; Testing and Professional Ethics.

The book is recommended to both elementary and secondary teachers, experienced and inexperienced. Reading the book served as a most excellent "brushing up" for the reviewer. It might do the same for you! —C.M.P.

DAVIES, EARL C. H. *Fundamentals of Physical Chemistry*. Philadelphia: P. Blakiston's Sons and Company, Inc., 1932. 370 p. $2.75.

The title of this work is well-selected since the author has presented the fundamental principles of physical chemistry in a clear and interesting manner. This book should be welcomed by all teachers who have classes in beginning physical chemistry which are made up largely of those students whose life work does not demand a rigorous mathematical treatment of the subject. It is especially adapted to the needs of students who are interested in the biological sciences. The subject matter is very well selected and is presented in such a way that college sophomores who have had courses in algebra and general chemistry should be able to handle the subject without much difficulty. It is the opinion of the reviewer that close connection between theory and practical application has been attained and that the book will prove very popular in the teaching of physical chemistry to sophomores.

The book contains 79 tables of useful data, numerous references to original articles and is remarkably free from misleading statements. There are sufficient problems and exercises at the end of each chapter to give the student a good review of the most important principles and to allow him to develop his ability to reason beyond the scope of the text.

JAMES L. KASSNER
University, Alabama

DAVIS, ELWOOD CRAIG. *Methods and Techniques Used in Surveying Health and Physical Education in City Schools*. New York: Bureau of Publications, Teachers College, Columbia University, 1932. 162 p. $2.00.

This is a doctor's dissertation in which answers are presented to fundamental administrative problems related to surveying health and physical education in city schools. The answers were derived by means of analysis of the development of survey methods and techniques; by analysis and evaluation of various general methods and techniques; and through an examination of various methods and techniques that are related to health and physical education surveys.

An extensive appendix includes criteria, directions, and rating sheets sent to selected experts who assisted in the study; analysis of 117 city school survey reports from 1910-1931; and survey forms for health and physical education used in the city schools of Fort Worth, Texas, in 1931.

This study will be of value to all who are interested in the improvement of surveying health and physical education in city school systems. —F.G.B.

HUGHES, WILLIAM LEONARD. *The Administration of Health and Physical Education for Men in Colleges and Universities*. New York: Bureau of Publications, Teachers College, Columbia University, 1932. 181 p. $1.75.

As a result of a comprehensive study, the author presents standards and policies that will serve as guides in the administration of health and physical education for men in colleges and universities. These standards and policies were formulated from extensive reading of literature and from the personal experiences of the author. They were revised and refined after visits to twelve colleges and universities and through conferences with approximately ninety individuals interested in some phase of health and physical education. They were then evaluated by selected specialists in the field. Administrators will find in them a basis for intelligent improvement in health and physical education. —F.G.B.

Science—A Tentative Syllabus for Elementary Schools, Grades 1-6. Course of Study Monograph, Number 18, Public Schools, Sacramento, California. June, 1932.

This is a tentative syllabus in science for the six grades of the elementary school and is published by the Board of Education of Sacramento, California. It has been worked out by a committee of teachers from the Sacramento schools under the leadership of Doctor Florence G. Billig who was formerly supervisor of science at Sacramento and who is now located at Detroit Teachers College.

The course, as presented, provides work in science for autumn and spring for each of the first six grades. General truths in science, appropriate for the various grades, are presented. Illustrations of truths, most appropriate for the Sacramento community, are given and many appropriate teaching procedures are suggested. This work is based upon recent curriculum research which has been made in the field of elementary science.

The science principles developed in this course are directed toward the development and understanding of a few large principles in both physical and biological science. The work is so organized that the relationships and meanings existing between the elements of learning are made clear and, in this way, the unity of science is emphasized. In the various grades the smaller general truths which are appropriate in difficulty for the grade in question; which contribute toward the development of an understanding of larger truths; and which are of general importance in interpreting the natural environment, are used. The need of giving pupils in the lower grades an abundance of experience with natural phenomena is recognized and provided for. Some applications of the principles are suggested in the course but these are made secondary to the principles and, for the most part, the applications are left for the teacher to work out. The goals for instruction which are set up in the course are appropriate for pupils in every kind of environment. The illustrations used are appropriate primarily for the Sacramento district but other illustrations may be found that are appropriate for other communities.

The material is so arranged that the work in each grade utilizes as a foundation the knowledge and skills given in the preceding grades. In this way the syllabus shows unity and gives a sequence in topics for the various grades that has progression and dependent continuity. This is a characteristic which has been lacking in grade science work in the past and this lack has probably been one of the most important factors in the retardation of the development of a real science course extending through the elementary school, high school, and college.

Not much work dealing with health is given but from a statement found in the syllabus one is led to suppose that the health work in the schools of Sacramento is to be taken care of in another course of study in health education. The course is probably stronger in biological science than in physical science.

This course of study represents the belief that science principles of proper size can and should be taught to pupils in the grades and that, by so doing, our young people will gradually develop an understanding of the few large generalizations of science and will, as a result, be better able to adjust themselves to their environment, where adjustment is necessary, and also better able to control or modify their environment when such control or modification is needed. The work presents an important contribution in the analysis of the larger principles of science into learning elements appropriate for teaching at various grade levels. It also shows how these smaller learning elements may be organized so that they will contribute most effectively to the ultimate development of an understanding of larger science principles.

—Harry A. Cunningham

Millikan, Robert A. *Time, Matter and Values.* Chapel Hill, N.C.: University of North Carolina Press, 1932. 99 p. $1.00.

This small volume contains three lectures: (1) "New Ideas about Time"; (2) "New Ideas about Matter"; (3) "New

Ideas about Values." The first theme traces the history of man's concept of time. The importance of the conception of time as an accurately measurable unit in the development of mechanics, and its influence upon the development of the formulations of force, velocity, and acceleration are emphasized.

The second lecture treats the history of the concept of discontinuous matter in much the same fashion as the first deals with time. It was a surprise to the reviewer to learn that some physicists and chemists doubted the necessity for the assumption of the discrete or particle structure of matter as late as 1900, that Oswald could champion the view that a continuous theory of the structure of matter could as well account for all the observed phenomena in 1903, and that it was not until 1913 to 1916 that two new facts were established which definitely clinched the argument. The author turns to the physics of the ether, reviews the development of the wave theory of radiation and then discusses recent evidence which indicates that waves may have some of the properties of corpuscles and that corpuscles may partake of the nature of waves.

The third lecture in the series discusses the relation between science and theology.

O. E. UNDERHILL

MEDSGER, OLIVER P. *Nature Rambles: Summer; Nature Rambles: Autumn.* (2 vols.) New York: Frederick Warne and Company, 1932. 160 p. each; $2.00 each.

How delightful it would be to take a summer or an autumn ramble with Mr. Medsger through the woods, along the brook, by the pond and marsh, along the country highway, along the seashore or over the hills! In these volumes the reader does so vicariously. The author tells you intimate little stories of things that he himself has seen as he describes the common birds, insects, flowers, plants, and animals to be found on summer and autumn rambles over the countryside.

The author is an all-round naturalist, being noted for his accurate observations and interpretations of nature. He uses a conversational, intimate style of writing that will appeal to boys and girls. The books are recommended for pupils of the upper elementary grades and the junior high school, for biology students, and for all others interested in the study of nature. Elementary-science teachers and biology teachers will find these volumes useful for reference purposes and as supplementary reading material. There are many excellent photographs and illustrations, several of which are in natural colors.

—C. M. P.

CARR, WILLIAM H. *The Stir of Nature.* New York: Oxford University Press, 1930. 208 p. $2.50.

The Stir of Nature is written by the Director of the famous Trailside Museum at Bear Mountain, New York. The author tells about bears, beavers, raccoons, owls, skunks, mice, crows, frogs, snakes, and other animal friends found along the trail. He tells how, when, and where to watch them. What interesting stories he tells about beavers, the departure of the herons, Sachet the Skunk, and Mark and Cleo, the pet crows! Boys and girls, teachers of biology and elementary science, camp leaders, and nature study directors will find this a most enjoyable book.

—C. M. P.

News and announcements

National Council of Supervisors of Elementary Science

MINUTES OF THE FOURTEENTH ANNUAL MEETING

The Fourteenth Annual Meeting of the National Council of Supervisors of Elementary Science was held in the Curtis Hotel, Minneapolis, on February 25, 1933.

The meeting was called to order promptly at 9:30 A.M. by the President, Dr. Lois Meier Shoemaker. The first two speakers, Miss Fay Rogers and Miss Theodora Agather, gave illustrated talks on science in the elementary schools of Minneapolis. Dr. Florence G. Billig read the paper submitted by Dr. Craig, who was unable to be present. Papers by Miss Mary Melrose dealing with the program in the Cleveland schools and by Mr. W. G. Whitman on teacher training in elementary science in Massachusetts closed the morning session shortly after noon.

After a recess of thirty minutes luncheon was served in the Solarium. Twenty-six members reserved places.

At 2:00 P.M. the President called the business meeting to order. The minutes of the previous meeting (the Washington meeting) were read and adopted. The following financial report was read by the Secretary-Treasurer and approved by the members:

FINANCIAL REPORT

February 25, 1933

Balance on hand March 1, 1932	$59.70	
Received in dues for 1932-33	78.00	
Received in dues for 1933-34	9.00	
Received in subscriptions and reprints for SCIENCE EDUCATION	39.35	
Total Receipts		$186.05
Expenditures:		
Multigraphing	$21.88	
Postage	27.76	
Telegram	1.12	
Printing of programs	5.15	
Printing of directory	30.57	
Printing of stationery	12.70	
Subscriptions and reprints to SCIENCE EDUCATION	39.35	
Government tax on checks issued	.38	
Express charges on materials shipped to Minneapolis	1.57	
Total Expenditures		$139.98
Balance on hand February 25, 1933		$ 46.07

The question of the correct time for payment of dues was brought up. The Secretary suggested that the new year should begin with the ending of the annual meeting and urged the payment of dues early in the spring; this suggestion was adopted.

Attention was called to the special subscription price for SCIENCE EDUCATION of $1.25 instead of $1.50, obtainable by members through the Secretary. Mr. W. F. Roecker, business manager of SCHOOL SCIENCE AND MATHEMATICS, announced a special rate for his periodical of $2.25 instead of $2.50, also available to members of the council through the Secretary.

The President called on Miss Lillian Hethershaw for a report as chairman of the Committee on Revision of the Constitution and By-Laws. Miss Hethershaw read the proposed revision in its entirety and then asked for comments from the membership. Discussion followed upon several of the divisions. The President finally requested that the constitution be accepted tentatively until copies could be distributed to all the members. This request was put into the form of a motion and carried: the Secretary is instructed to mail to each member a copy of the revised constitution; final acceptance or rejection is to be made at the 1934 meeting.

The report of the Joint Committee of the American Nature Study Society and the National Council of Supervisors of Elementary Science was read by the Secretary. The members of this Committee were: Miss Jennie Hall, George Green, Ellis C. Persing, and W. W. McSpadden. This report sets forth the spheres of activity of these two organizations. The following are the principal conclusions of the report.

1. The National Council of Supervisors of Elementary Science should in every way possible promote the development of a science education program in schools of all kinds, including teacher-training institutions.

2. The American Nature Study Society should coöperate and support such a program through research, bulletins of subject matter and teaching devices, lectures, museum aids and other agencies. Further, the American Nature Study Society should aim to coördinate nature workers, nature literature, nature education into a tangible form to better function in the life of our youth and our adults.

The President called for nominations for a representative on the Editorial Board of SCIENCE EDUCATION. Dr. Shoemaker was nominated by Mr. Carpenter and elected without opposition.

The Secretary was instructed to reserve a block of hotel rooms to serve as headquarters for the Council as soon as the meeting place of the National Education Association has been determined.

The Nominating Committee suggested as officers for the coming year:

For *President:* Florence G. Billig, Detroit Teachers College, Detroit, Michigan.
For *Vice-President:* W. G. Whitman, State Teachers College, Salem, Massachusetts.
For *Secretary-Treasurer:* W. W. McSpadden, Austin Public Schools, Austin, Texas.

The meeting voted acceptance and election.

Before adjournment of the business session, the Secretary was instructed to send Miss Jennie Hall of Minneapolis an official letter of appreciation for making many of the local arrangements that facilitated the progress of the meeting.

The program scheduled for the afternoon session was then presented. Dr. Shoemaker read the paper submitted by Miss Claudia Schmidt who was unable to be present. Miss Esther Scott presented a paper, very fully illustrated with lantern slides, on school garden activities in the District of Columbia Public Schools. Dr. W. C. Croxton's paper concerned the philosophy of the teacher of elementary science.

A representative of Erpi pictures gave an impressive showing of talking pictures available for elementary science.

The session was unusually well attended, there being present at the morning session more than a hundred and fifty.

W. W. MCSPADDEN
Secretary-Treasurer

The Science Association of the Middle States

I. Report of the Twelfth Annual Meeting

The twelfth annual meeting of the Association was held in the Roberts Room, Hotel Chalfonte, Atlantic City, November 26, 1932, with the President, Professor W. L. Eikenberry, in the chair.

The following program was followed:

Address—*New Angles of the Problem of Laboratory Work versus Demonstration in the High School.*
F. A. Riedel, Wilson Teachers College, Washington, D.C.

Address—*Science in Education.*
S. R. Powers, Teachers College, Columbia University.

Report of the Committee on Laboratory Teaching-Load Standards of the Association of Colleges and Secondary Schools.
Pauline Atkins, Supervisor of Science, Elizabeth, N.J.

Discussion

Subscription luncheon—Blue Room

Business meeting

Address—*Moving Pictures with Sound, for Educational Use*
Dr. M. R. Brunstetter, Research Associate, Electrical Research Products, New York City.

The Committee on Laboratory Teaching-Load Standard (Mrs. Pauline McD. Atkins, Chairman, Elizabeth; M. Louise Nichols, Philadelphia; Rufus D. Reed, Montclair) reported on Standard 5 of the Association, relative to the double laboratory period, especially to "In interpreting this standard a double laboratory period of laboratory work or of study room supervision may be counted as the equivalent of one period of teaching." The committee made a general survey to find to what extent the double laboratory period is being used, and what evidence exists that the standard gives the teacher an unfair teaching load. The report submitted the results of Woody and Bergman and of unpublished data by Dr. Reed of Montclair. "It is the sense of this Committee that this Association should send to the Commission on Secondary Schools of the Middle States Association of Colleges and Preparatory Schools the recommendation that the second paragraph 5, be changed to read as follows: "In interpreting this standard a double laboratory period shall be counted as equivalent to two classroom periods; two study room supervision periods may be counted as equivalent to one period of teaching."

After Mrs. Atkins' paper a motion was made that the Committee be continued. This motion was seconded and carried. A brief report was then presented by Dr. Jameson of work that had been done by the Committee for Study of College Entrance Examinations in Physics and Chemistry. Following his report some correspondence was read by the secretary, Miss Towle, relating particularly to the situation in Chemistry. This correspondence was carried on between the Head of the Baldwin School and various members of the C.E.E.B. and called attention to the fact that it is very difficult to cover the requirements embodied in the Chemistry syllabus, and still have time for training students in independent thought. A motion was made by Dr. M. Louise Nichols, seconded and carried by the Association, "that this Association recommend revision of the requirements in Physics and Chemistry, and that its Committee on Entrance Requirements present to the College Entrance Examination Board sample examinations in these subjects."

At the business meeting, the minutes of the previous meeting were accepted as printed in Science Education.

The slate of the Nominating Committee was read by the Chairman, Dean Wini-

fred Robinson, and elected, after motion properly made and seconded that the Secretary should cast the ballot, as follows:

President—Professor W. L. Eikenberry, State Teachers College, Trenton, N.J.

Vice-President—Professor Winthrop R. Wright, Head of Department of Physics, Swarthmore College, Swarthmore, Pa.

Secretary-Treasurer—Miss Dena D. Ungemach, Head of Department of Science, Overbrook High School, Philadelphia.

Members of Council—Miss Elizabeth W. Towle, Baldwin School, Bryn Mawr, Pa.; Dr. M. Louise Nichols, Head of Science Department, South Philadelphia H.S., Philadelphia; Mr. Leighton K. Smith, Northeast H.S., Philadelphia.

The following report from the Treasurer was accepted:

Receipts

Balance on hand November 27, 1931	$ 85.40
Sale of luncheon tickets, November 28, 1931	40.25
Dues received November 27, 1931, to November 23, 1932	56.00
Total	$181.65

Disbursements

Luncheon expenses November 28, 1931	$ 40.50
Lantern and operator	5.00
Expenses of speakers 1931 meeting	52.98
Mimeographing	2.10
Postage	6.36
Total	$106.94
Balance on hand	$ 74.71

After a suggestion by the President that if ten of the members would subscribe to SCIENCE EDUCATION it could be obtained at a reduced rate, a motion, duly made and seconded, was passed to the effect that SCIENCE EDUCATION be made the official organ of the Association.

The meeting adjourned at 12:30 P.M.

After the luncheon the members assembled again in the Roberts Room to listen to an address by Dr. Brunstetter on the development of Moving Pictures with Sound for Educational Use, as sponsored by the University of Chicago. He showed two films: "Oxidation and Reduction" and "Molecular Theory of Matter." Because of the interest shown, several other reels were run off. The meeting adjourned at 3:30 P.M.

DENA D. UNGEMACH
Secretary-Treasurer

II. ABSTRACTS OF ADDRESSES

Address by Mr. Riedel: *New Angles of the Problem of Laboratory Work versus Demonstration in the High School.*

Mr. Riedel presented the results of experiments dealing with more than 600 cases, performed in Kansas and New York high schools over a period of 4 years (1927-1931). He tabulated his results, showing superiority of the laboratory method or of the demonstration method according to outcomes and objectives. Mr. Riedel distributed mimeographed sheets showing careful analyses of the two methods, dealing with Memory and Understanding, Economies, Training values, Interest and Attention, Discrimination in needs, etc. When completed, the study will be an important contribution to the problem of laboratory work, especially at a time when Boards of Education are attempting indiscriminate economies. (Copies of his analysis may be obtained from Mr. Riedel.)

Address by Dr. Powers: *Science in Education.*

The developments in science have come as a result of man's desire for knowledge. Outstanding among human desires that have stimulated scientific study have been desires for health, for leisure, and for a mental adjustment that will result in a feeling of security for mind and body and that will enable the individual to live without ignorant fears for his own well being. The attainments that have come in response to these desires have changed, and are now changing, the physical character of the social order as well as the systems of thought that guide human behavior. Science is more than practical—using the term in its narrower sense. It is more than technology. The findings from science are exerting an enormous influence on liberal thought. In fact any real understanding of modern life and thought is impossible without some understanding of those comprehensive concepts which have developed for the most part through study in the field of natural science.

Progress in attaining leisure has been attained through the use of energy to do the work of the world. Men have been freed in part from the drudgery of toil. Our social order of today, in contrast with the past, is characterized by developments in technology that have come as a result of an acquired control of transformations of energy. The forces in nature, with their origins in solar radiation, are applied to machines and used to do the work of the world. An enormous stream of energy flows from our natural resources through these machines. This stream of energy, with its origin in solar radiation, will continue to flow as long as the sun shines. Only a part of the total is now utilized. There is an abundance for every conceivable need and much to spare.

With energy under control, facilities for production have increased at an enormous rate. Our economic order can now produce more of the necessities of life than can be used and at the same time it can allow an abundance of leisure. Facilities for distribution have not kept pace with production. With excessive overproduction of the things that make for comfort, there is at this time a large proportion of our population suffering for want of food, clothing, and shelter. It appears that this anomalous condition of overproduction on one hand and suffering from want on the other is in large part due to lack of understanding of the importance of energy in the life of today. Education, and in particular education in science, must assist in the interpretation and solutions of problems associated with this rapid development.

Under the influence of anthropomorphism many errors in understanding have arisen. Man has cherished a belief that natural forces are operating for or against his welfare. He has worshipped the sun and has stood in terror before comets and eclipses. He has sought for a feeling of security in the presence of natural forces and he has sought for evidence that there are, or are not, forces that predestine successes and failures. Phenomena in nature have been seen as agencies associated with the well being or with the punishment of men.

Modern times have seen a rapid advance in knowledge of the nature of things. Knowledge at hand contradicts many of the beliefs of an earlier day. Man's conceptions of truth have changed. Phenomena are interpreted as effects which result from natural causes, many of which are now well understood. New systems of thought have developed from this new knowledge. These are taking their place as elements that mark the progress of civilization. It is during the comparatively recent period that science has taken a place of prominence as a force influencing the systems of thought that govern human behavior.

Guided by their own desires, scientists have produced a body of knowledge about control of energy, control of the causes of ill health, meteorological phenomena, heredity, natural and artificial selection, cosmic and biological evolution, time, space, life processes, chemical changes, gravitation, machinery, and the nature of matter. There are in these attainments potentialities for attaining health and leisure and potentialities for attaining a mental adjustment that is satisfying in the sense that it is

based, at least in part, upon understanding of the phenomena of nature. These considerations are closely associated with human interests. They stimulate intellectual activity. A task of the school is to give to learners some orientation with respect to these influences. The objectives of science in education are sought in these considerations.

The study of science contributes to the attainment of the aim of education through its contributions to the attainment of understanding of the problems associated with living. Specific objectives are the goals set for attainment through instruction. The science teacher may turn for guidance in the selection of specific objectives to those principles and generalizations that ramify through the life of today. This approach will associate the achievements of science with the problems of society and with the problems of individuals.

In their origins, the scientific attitudes are necessarily associated with understandings and with exercise in the use of understandings in the process of thinking. Apart from positive and identifiable attainments in the form of understandings and abilities, the term, "scientific attitude," seems meaningless. A scientific attitude is an attitude toward methods and achievements. In the learning process these attitudes develop as concomitants to understanding of scientific achievements and scientific methods. The attainment of scientific attitudes represents the highest accomplishment from study in science.

In our program for science in education we must seek for guidance in the world of affairs. Teachers must be liberally educated. Special attention must be given to programs for the professional education of teachers. The importance of science in the life of today is adequate support for a program of science teaching that shall be continuous throughout the grades of the public schools. Elementary experiences with immature children will serve as a foundation for the continuous enlargement of learning as the children grow more mature. Progress in this work of imparting liberal education requires that we focus our attention more directly upon problems associated with the life of today. It is not the purpose of the elementary and secondary schools to develop specialists. The purpose of science in education is to develop understanding of, and to develop ability and desire to use, those principles and generalizations of science that are important because of their ramifications into the problems of everyday affairs, and because of their ramifications into the systems of thought that guide the behavior of men.

Iowa Elementary Science Section Meeting

The Elementary Science Section of the Iowa State Teachers Association held their program and exhibits in the science rooms of the Administration Building at Drake University, Des Moines, Iowa, November 4, 1933.

The program consisted of the following papers:

"An Integrated Science Program in the Public Schools" by J. H. Jensen, head of the Science Department, Northern Normal and Industrial School, Aberdeen, South Dakota.

"Problems in a Superintendent's Mind concerning Elementary Science work in his Schools," by B. C. Berg, Superintendent of Schools at Newton, Iowa.

An exhibit of pupil activities in science from grades 1 to 6 of school systems in Iowa was on display in the science rooms. The exhibit of science units was very representative of work from each of the six grades, and of different school systems.

One hundred and fifteen books for pupils and teachers in the following fields were on display: (1) fur bearing animals, (2) astronomy, (3) miscellaneous list of books in science for pupils in grades 1 to 6.

Visual materials for teaching elementary science were also exhibited, such as lanterns, lantern slides, 16 mm. moving picture machines with science films, sources of birds, trees, wild flowers, pictures, charts, etc.

The officers of the organization were: Miss Lillian Hethershaw of Drake University, *President*, Miss Romaine Startzer of Newton, Iowa, *Secretary-Treasurer*.

Over one hundred from the state visited the exhibits, seventy-five were in attendance at the program, also about two hundred teachers taking science in the College of Education visited the exhibit.

The section was formed in November, 1931. This was the first state program and the first state exhibit of science in this field.

Study on Project in Science Education Made by the American Institute 60 East 42nd Street, New York City

BOOK ON CHILDREN'S SCIENCE FAIR ANNOUNCED

A detailed account of the Children's Science Fair has recently been published by The American Institute. The Fair, held each year by The American Institute at the American Museum of Natural History, for school children of New York City, has become a leading project in progressive science education.

"Each year," says Mr. L. W. Hutchins, Director of the Institute, "educators from all the surrounding colleges come to the Museum to study this undertaking. Representatives from different Museums over the country, such as the new Museum of Science and Industry in Chicago, the Buffalo Museum of Science and many others have spent several days with us going over each detail of procedure with a view to establishing similar Fairs in their cities.

"Requests from every major country in the world have come to us for information" Mr. Hutchins states. "This tremendous interest in science education has led us to present our project in a detailed treatise.

"The book, 'The Children's Science Fair—a Project in Science Education,' by Dr. Morris Meister, Head of the Science Department of New York Teaching Training College and Chairman of the Plan Committee for the Fair, is written especially for science teachers and those museums and institutions which are interested in advancing the educational methods of their communities.

"Our publication," says Mr. Hutchins, "gives every step in the business of planning and actually handling a Science Fair, even to details of coöperating groups to be approached, reproductions of booklets of directions to go to the children, form letters which must go to all concerned, prize cards, identification cards and all the multiple arrangements which must be made. We feel that there is enough material here to make it possible for any other organization to prepare a similar Fair with only this book as a guide.

"In addition to the actual details, the book makes clear the underlying principles which must be kept in mind every step of the way.

"This year, in New York City, we had 478 exhibits representing the work of some 7,000 or more school children. The projects were displays of innumerable scientific principles and scientific observations. They were entirely the work of the child exhibitors. The recognition of this amazing interest of children in science leads us to believe that the Science Fairs are a leading factor in the advancement of educational methods."

Science Tour to Germany, 1933

The Science Tour to Germany, conducted by Teachers College, Columbia University, in the summers of 1932 and 1933, undertook two main lines of study: an integrated field study of the science of definite regions and a study of science education and of institutions and activities relating to science education.

Elementary and secondary schools in the village of Gehrde and the cities of Berlin and Hamburg were visited. It was obvious that the outdoor excursion plays a greater rôle in German science education than in American.

School gardens in Düsseldorf, Frankfurt am Main, and Berlin were visited. In each case the school garden functioned as an outdoor laboratory for the science work in the schools connected with it.

In Trittau, the school country home of the elementary school on the Ahrensburgerstrasse in Hamburg was visited. Here in a roomy country house, surrounded by meadows and forest, members of a fifth and sixth grade lived together with their two teachers for eleven school days. They studied the geography and science of the region and the history and occupations of the villagers; they learned to play and work together companionably. A noticeable improvement in health and spirits results during the period.

In Bonn the halls of the teachers college were quiet; the students were all in country schools teaching and observing. At night students and faculty met in village inns to discuss the practical experience of the day past, and procedures for the day to come. Here in Bonn, during a semester of *Heimatkinde*, or community study, the students with members of the faculty giving each course spend one day each week on a field trip. This coöperation makes more time available for outside work in each subject and gives the student an integrated view of his surroundings. Science and geography, history and art, poetry and music share in these excursions.

Outstanding institutions visited were Planetaria, the German industrial museum in Munich, the Hygiene Museum in Dresden, Hagenbeck's Zoo in Hamburg, and the Berlin Zoo and Aquarium, with its unique Kinderpark where children can see and play with the young of various animals.

Long days of companionable tramping over age-old mountain paths or along highways where motor vehicles were rarities marked the six weeks of the tour. The host of experiences and memories and impressions are too numerous to describe in brief. Some of the pictures that still shine on that "inward eye" are the blaze of native red foxglove on the slopes below the overhanging cliffs of conglomerate at Nideggen; the majesty of the columned basalt under the earth at Niedermendig; the still beauty of the crater lakes at Daun; the tall firs of the Black Forest, where brooks and rivers have their origin at the foot of the snow-capped Zugspitze; the curious rock formations of Saxon Switzerland; the rosy glow of the heather on the August *Heide* of the North German Plain.

Among the experiences of the summer must be counted, also, the friendships developed with German people, teachers and others.

LOIS MEIER SHOEMAKER